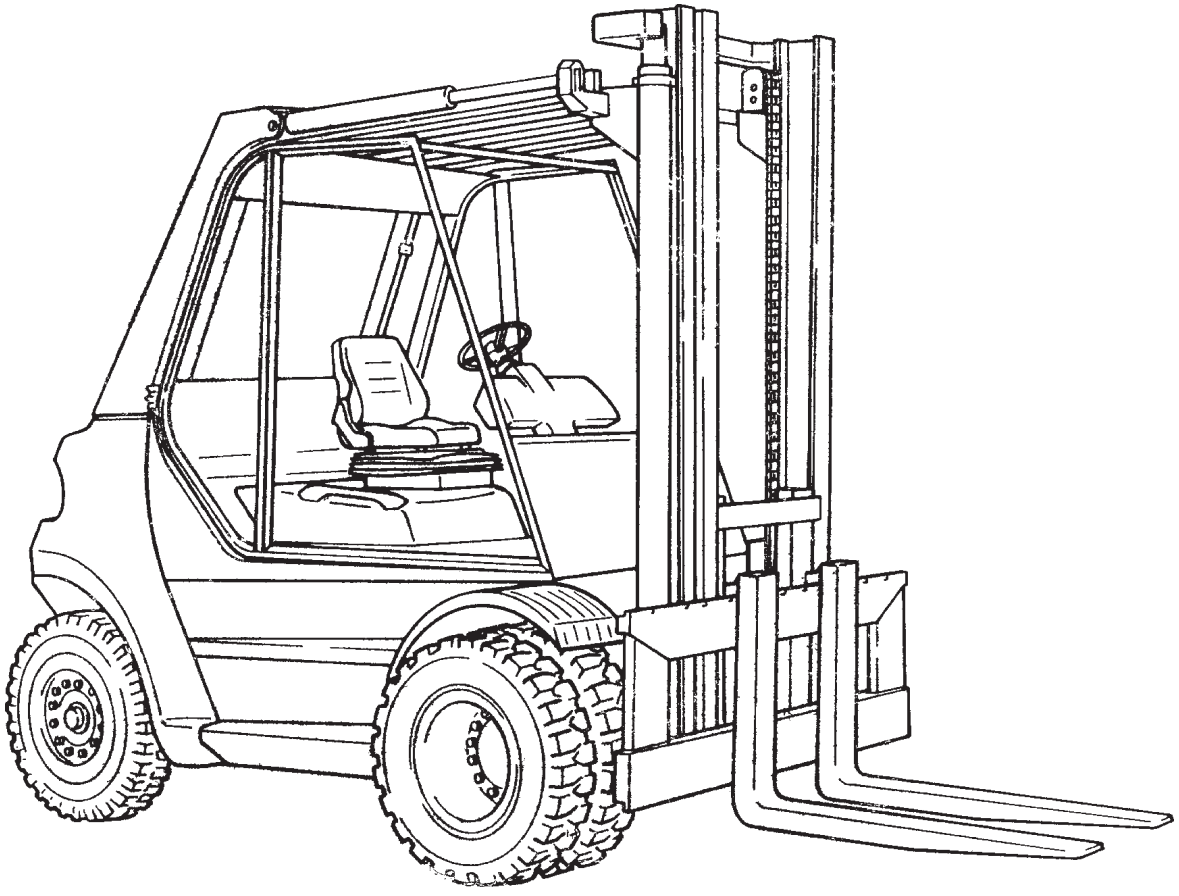
Service Training

Linde IC-Engined Fork Truck
H 50/60/70/80 D/T
H 50/60/70/80 D-02/T-02
H 50/60/70/80 D-03/T-03
Type 353



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LINDE MATERIAL HANDLING

TABLE OF CONTENT

4	IC-engined fork truck H 50/60/70/80, Type 353	1
4.1	Engine drive	1
4.1.1	Engine model BF6M 1012 E	1
4.1.1.1	Engine specifications	1
4.1.1.1.1	Explanation of the engine number	2
4.1.1.2	Changing and tightening the drivebelt	3
4.1.1.3	Adjusting valve clearance	4
4.1.1.4	Adjusting the injection valve	7
4.1.1.5	Checking the compression pressure	9
4.1.1.6	Cylinder head	10
4.1.1.7	Adjusting the begin of delivery	12
4.1.8	Special tools	16
4.1.2	Engine model BF6M 2012	18
4.1.2.1	Overview of engine components	18
4.1.2.2	Engine specifications	20
4.1.2.2.1	Explanation of the engine number	11
4.1.2.3	Replacement of V-ripped belt	22
4.1.2.4	Adjusting valve clearance	23
4.1.2.5	Checking and adjusting leak-fuel-free injection nozzles	24
4.1.2.6	Thermostat	30
4.1.2.7	Checking the compression pressure	32
4.1.2.8	Cylinder head	33
4.1.2.9	Injection pump	35
4.1.2.9.1	Adjusting the begin of delivery	35
4.1.2.9.2	Replacement of the injection pump	37
4.1.2.10	Heater flange	43
4.1.2.11	Special tools	46
4.2	Transmission	1
4.2.1	Hydrostatic transmission	2
4.2.1.1	Schematic diagram of the drive	3
4.2.1.2	Transmission specifications	4
4.2.1.3	Hydraulic circuit diagram	6
4.2.2	Operation of the hydrostatic transmission	20
4.2.2.1	Travel control unit P	20

4.2.2.2	Operation of control valve block N = Power Limiter	23
4.2.2.3	Braking	24
4.2.2.4	Auxiliary brake	24
4.2.2.5	Lock-out logic - reversing lock	26
4.2.2.6	Flushing of the circuit and housing	28
4.2.3	Hydraulic remote control	30
4.2.3.1	Adjustments	31
4.2.3.1.1	Hydraulic neutral position	31
4.2.3.1.2	Primary adjustment of start of control	31
4.2.3.1.3	Mechanical limitation of the swashplate angle	31
4.2.3.1.4	Hydraulic remote control HPV 105 -02	32
4.2.3.1.5	Reversal lock (logic lock out)	34
4.2.3.1.6	Reducing the truck speed	34
4.2.4	Wheel drive	35
4.2.4.1	Reduction gearbox with disc brake (GR 80 -02/-03/-04)	36
4.2.4.2	Servicing the reduction gearbox (GR 80 -02/-03/-04)	38
4.2.4.3	Disc brake repairs	39
4.2.4.4	Reduction gearbox GR 80 -06 with multiple disc brake	40
4.2.4.5	Repair on the reducing gear GR 80 -06	41
4.2.5	Troubleshooting	48
4.2.5.1	Connecting diagram for troubleshooting	48
4.2.5.2	Tools and aids for measurements	50
4.2.5.3	Explanations to troubleshooting	52
4.2.5.4	Hydraulic speed control for the engine	53
4.2.5.4.1	Functional test	53
4.2.5.4.2	Troubleshooting	53
4.2.5.5	Hydraulic braking system	58
4.2.5.5.1	Functional test	58
4.2.5.5.2	Troubleshooting	58
4.2.5.6	Pressure equality and start of control	61
4.2.5.6.1	Functional test	61
4.2.5.6.2	Troubleshooting	61
4.2.5.7	Hydrostatic travel drive	65
4.2.6	Test and adjustment instructions for hydraulic primary and secondary control	77
4.2.6.1	Q_{max} of variable displacement pump BPV 100	78
4.2.6.2	Q_{max} of hydraulic motors HMV 105	80
4.2.6.3	Q_{min} of hydraulic motors HMV 105	81

4.3	Chassis	1
4.3.1	Overhead guard - torsion mounting	2
4.3.1.1	Work on the overhead guard	3
4.4	Steering system	1
4.4.1	Power steering circuit diagram	2
4.4.2	Series 304 steering axle	4
4.4.2.1	Description	4
4.4.3	Steering axle removal	5
4.4.3.1	Steering axle installation	6
4.4.4	Steering axle repairs	6
4.4.4.1	Renewing the wheel bearings	7
4.4.4.2	Steering knuckle removal and installation	8
4.4.4.3	Steering cylinder removal and installation	10
4.4.4.4	Replacing the steering cylinder seals	12
4.4.4.5	Steering stop adjustment	13
4.5	Controls	1
4.5.1	Accelerator and brake pedal adjustment	2
4.5.2	Speed control	5
4.5.2.1	Speed control up to 10/95	5
4.5.2.2	Speed control from 11/95	7
4.5.3	Medium wheel speed	8
4.5.4	Start of drive wheel rotation	9
4.5.5	Brake shaft stop screws	10
4.5.6	Symmetry of the travel control	11
4.5.6.1	Drive wheel start of rotation	11
4.5.6.2	Engine speed increase	12
4.5.7	Pressure difference Δp	13
4.5.8	Modification of engine acceleration	14
4.6	Electrical system	1
4.6.1	Wiring diagram	2
4.6.2	Wiring diagram for options	6
4.6.3	Wiring diagram, 353 -02	9
4.6.4	Wiring diagram for options, 353 -02	13
4.6.5	Wiring diagram, 353 -03 Diesel	17
4.6.6	Wiring diagram for options, 353 -03	21

4.6.7	Electrical system circuit diagram, type 353 -03 LPG	25
4.6.8	Wiring diagram for options, 353 -03	29
4.6.9	Central electrical system	34
4.6.10	Central electrics of series 353 -03	36
4.6.10.1	Relay and fuses of 353 -03 Diesel	36
4.6.10.2	Relay and fuses of 353 -03 LPG	38
4.6.10.3	Relay and fuses for 353 -03 particulate trap	40
4.7	Working hydraulics	1
4.7.1	Working hydraulics circuit diagram	2
4.7.1.1	Explanation of the working hydraulics	3
4.7.2	Tilt cylinder	4
4.7.2.1	Tilt cylinder removal, installation, adjustment, sealing	5
4.8	Mast	1
4.8.1	Mast removal	2
4.8.2	Lift cylinder removal, installation	3
4.8.3	Sealing the lift cylinder	4
4.9	LP gas model H 50/60/70/0, Type 353	1
4.9.1	Drive engine	1
4.9.1.1	Technical data on engine	1
4.9.1.1.1	Technical data on engine up to 12/2004	1
4.9.1.1.2	Technical data on engine from 01/2005	2
4.9.1.2	Note on the engine number	3
4.9.1.3	Changing and tensing V-belt	4
4.9.1.4	Checking and setting valve clearance	5
4.9.1.5	Removing and installing the cylinder head	6
4.9.2	Electrical system	9
4.9.2.1	Electronic ignition system	9
4.9.2.1.1	Electronic ignition system up to 12/2004	9
4.9.2.1.2	Electronic ignition system from 01/2005	14
4.9.2.1.2.1	Mechanical ignition timing	19
4.9.2.2	Electronic engine-speed control	23
4.9.2.3	Electrical system circuit diagram	26
4.9.2.3.1	Electrical system circuit diagram up to 12/2004	26
4.9.2.3.2	Electrical system circuit diagram from 01/2005	30

4.9.3	Propellant gas system	33
4.9.3.1	Diagram	33
4.9.3.2	Functional description of the propellant gas system	34
4.9.4	Inspections and adjustments	42
4.9.4.1	Ignition system	42
4.9.4.2	Installation of the engine speed control system	46
4.9.4.3	Inspection of the engine speed control system	48
4.9.4.4	Adjustment of the propellant gas mixers	53

4 IC-ENGINED FORKTRUCK H 50/60/70/80, TYPE 353

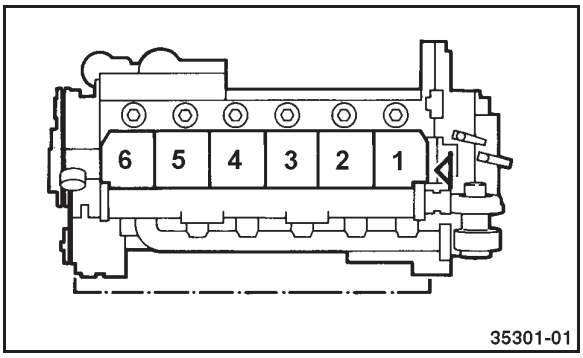
4.1 ENGINE DRIVE

4.1.1 ENGINE MODEL BF6M 1012 E

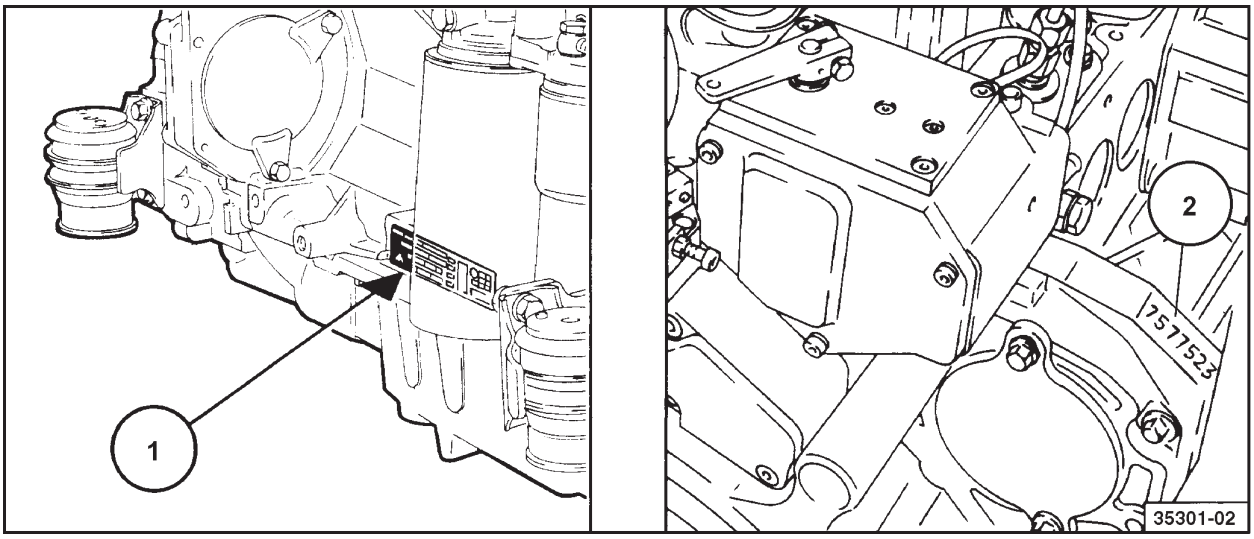
4.1.1.1 ENGINE SPECIFICATIONS

Engine model	BF6M 1012 E
Displacement	4790 cc
Power	85 kW at 2250 rpm
Opening pressure of injection valve	260 bar
Compression ratio	17,5 : 1
Compression	28 - 33 bar
Maximum difference in pressure	4 bar
Firing order	1 - 5 - 3 - 6 - 2 - 4
Valve clearence (cold)	inlet: 0,3 $^{+0,1}$ mm
	outlet: 0,5 $^{+0,1}$ mm
Lower idling speed	750 $^{+50}$ rpm
Upper idling speed	2300 $^{+50}$ rpm
Oil pressure at lower idling speed and 125 °C oil temperature	min. 0,8 bar

Count the cylinders beginning at the flywheel end.



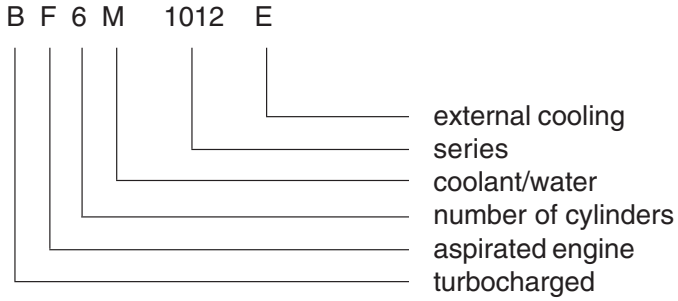
4.1.1.1.1 EXPLANATION OF THE ENGINE NUMBER



1 Manufacturer's plate with type and engine number
2 Engine number stamped on the crankcase

NOTE: A second type plate was affixed to the rocker cover by Linde.

EXPLANATION OF THE ENGINE NUMBER



4.1.1.2 CHANGING AND TIGHTENING THE DRIVEBELT

CHANGING THE DRIVEBELT

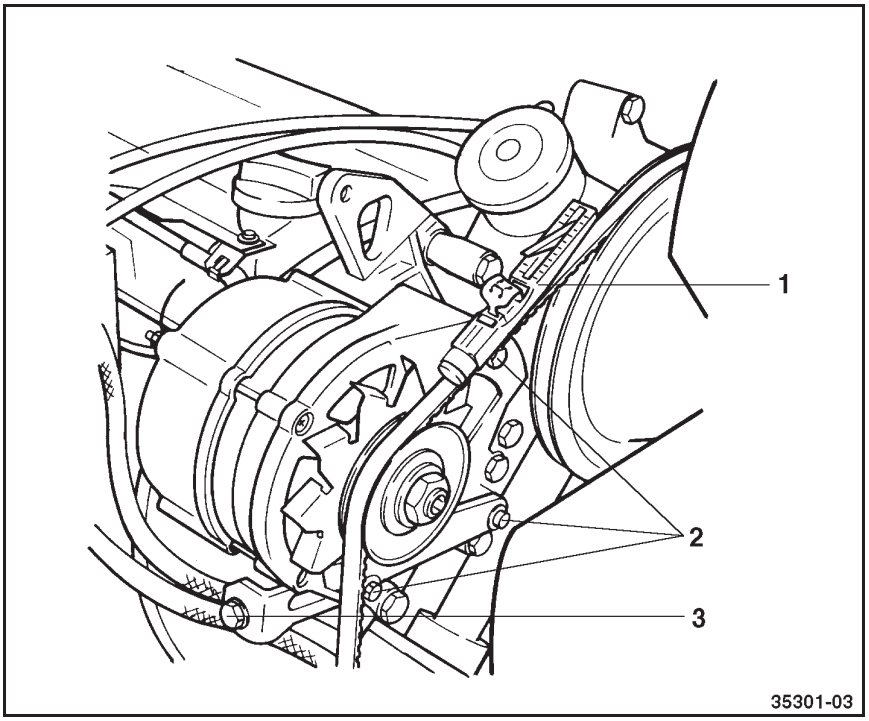
- Slacken the alternator and tensioner fastening screws (2).
- Turn the tensioning screw (3) anti-clockwise, press the alternator in and remove the drivebelt.
- Check the pulley for wear, renewing it if necessary.
- Install a new drivebelt.

TIGHTENING THE DRIVEBELT

- Turn the tensioning screw (3) clockwise until the required tension is obtained.
- Check the tension with a gauge (1), Part No. 000 941 9435.
- Tighten the screws (2) again.

Settings:

Initial installation	400 $^{+50}$ N
Check after 15 minutes Operation under load and retighten the belt, if necessary	300 ± 50 N
With re-use	250 ± 50 N



4.1.1.3 ADJUSTING VALVE CLEARANCE

The adjustment can be carried out when the engine is cool or warm after a cooling period of at least 30 minutes (oil temperature < 80 °C).

Valve clearance: Inlet 0.3 mm
Outlet 0.5 mm

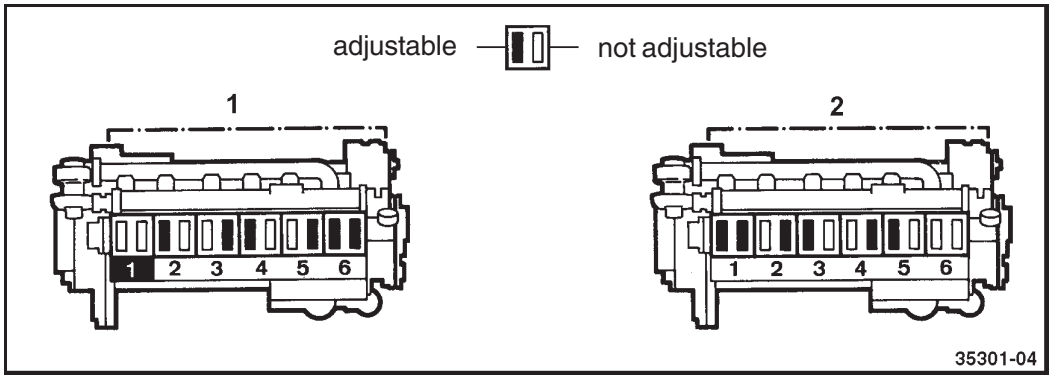
VALVE CLEARANCE SCHEMATIC

Crankshaft position 1

Turn the engine until the valve inlet and outlet of cylinder 1 are just open.

Crankshaft position 2

Turn the engine one full revolution (360 °).



NOTE: When a new rocker cover is installed, increase the valve clearance by 0.1 mm. Adjust the valve clearance to normal values after 50 service hours.

VALVE CLEARANCE ADJUSTMENT BY MEANS OF A TORQUE ANGLE GAUGE FROM SERIAL NUMBER E1 X353 T 000268

In engines which are equipped with a thrust washer in the valve spring retainer (Fig. A1), the valve clearance can only be adjusted **by means of a torque angle gauge**.

This method using a torque angle gauge may also be applied for the DEUTZ engines BF6M 1012 / 2012 installed in series 353 trucks up to now, which have so far been adjusted by means of the feeler gauge method.

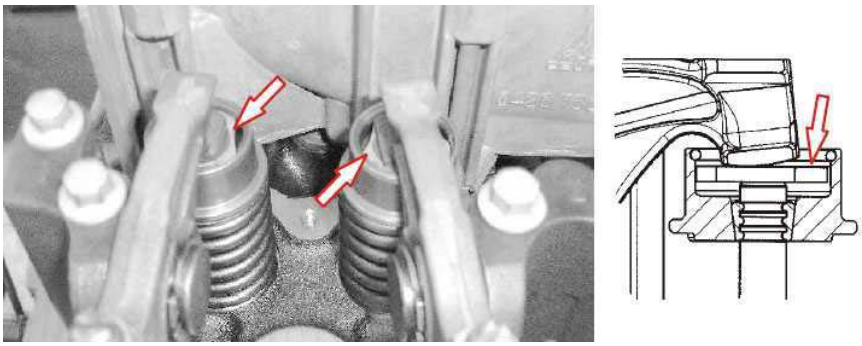


Fig. A1 Valve gear with pressure disk

New method for checking and adjusting the valve clearance (with torque angle gauge)

Prerequisite: The engine must have cooled down for at least 30 minutes; oil temperature below 80 °C.

- Carry out the preparations (e.g. remove cylinder head cover).
- Turn crankshaft until valve overlap on cylinder no. 1 is reached. This means: Inlet valve starts opening, outlet valve closes.
- Crankshaft position 1 in accordance with corresponding adjustment diagram (see "valve clearance schematic").
- Fix magnet of torque angle gauge on cylinder head.
- Place torque anlge gauge 8190 with screw driver bit on setting screw. Use screw driver bit 8191.

Checking the valve clearance

- Put T-handle (4) on torque angle gauge (1) (Fig. 5).
- Loosen locknut (3) on rocker arm and support setting screw (2) with T-handle against turning (figure A5).
- Set torque angle gauge to 0 (zero) and suppport setting screw (2) with T- handle against turning (figure A4).
- Turn setting screw with screw driver bit clockwise until rocker arm contacts thurst washer free from clearance.
- Read the value (setting angle) on the torque angle gauge.

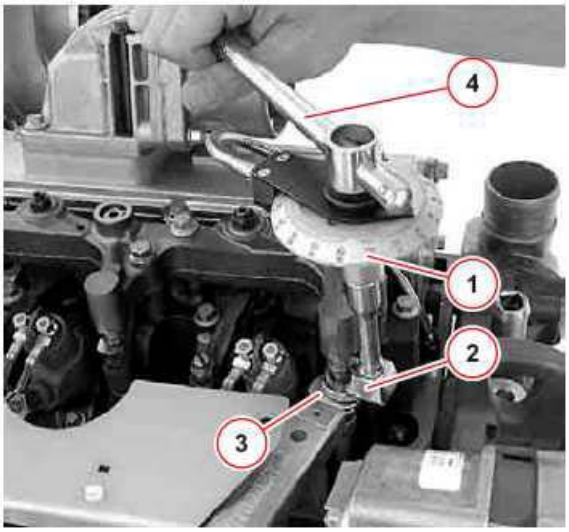


Fig. A5

Adjustment of valve clearance

- Set torque angle gauge to 0 (zero) (Fig. A4). Take care not to turn the setting screw!
- Turn setting screw back (counter-clockwise) until reaching the corresponding setting angle.

  Setting angle of inlet valve: 75°
  outlet valve: 120°
  Locknut tightening torque: 20 Nm

- Put T-handle on torque angle gauge (Fig. A5).
- Support setting screw with T-handle and tighten locknut with socket wrench (open end). Observe instructions for tightening!
- Adjust valve clearance for the remaining valves as described above.
- Remove tools.

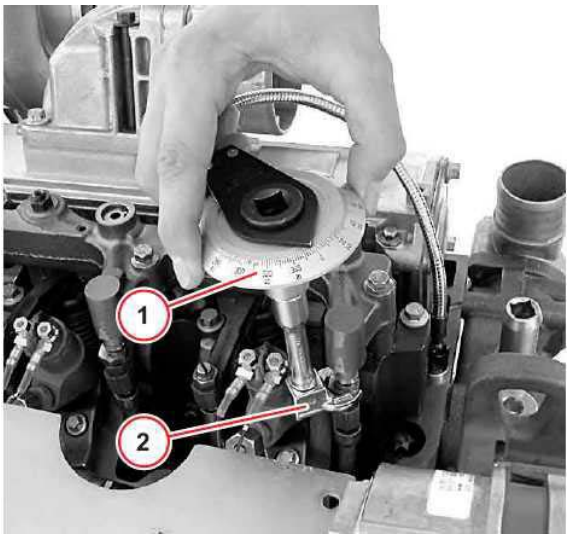
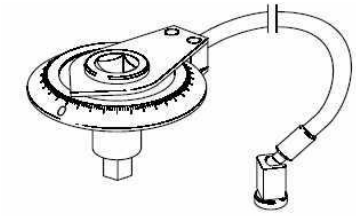


Fig. A 4 Valve clearance adjustment (example: TCD 2012 2V with exhaust gas recirculation)

1 = Torque angle gauge 8190

Tools required for adjustment



Deutz part number	8190	8191

The required special tools may be ordered from the address below.
Please quote the corresponding ordering number.

WILBÄR
Wilhelm Bäcker GmbH & Co. KG
Postfach 140580
D42826 Remscheid
E-Mail: info@wilbaer.de
Tel.: ++49 (0) 2191 9339-0

4.1.1.4 ADJUSTING THE INJECTION VALVE

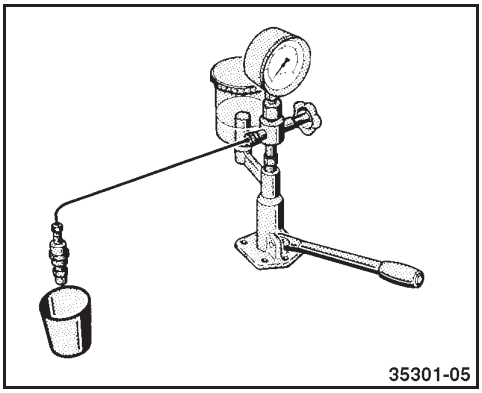
CHECKING THE OPENING PRESSURE

NOTE: Use only test oil acc. to ISO 4113 or diesel fuel for the test.

CAUTION: When checking injection nozzles, take care that the fuel jet does not hit the hands. Due to the high pressure, the fuel can penetrate the skin and cause severe injuries.

- Install the injection nozzle on the nozzle tester.
- Press the lever down slowly. Read the pressure at the start of fuel ejection and adjust the pressure, if necessary, by changing the shims.

Specified pressure
New injection nozzles 260 $^{+8}$ bar
Pressure for re-usability 255 $^{+8}$ bar

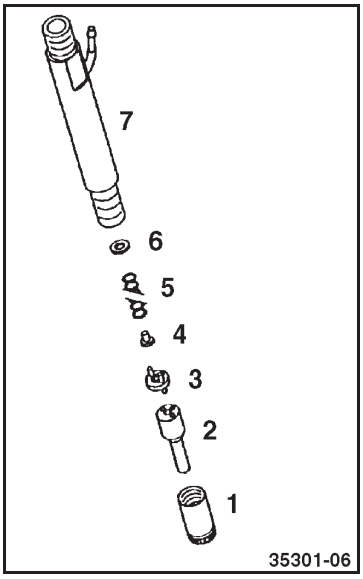


ADJUSTING THE INJECTION NOZZLE OPENING PRESSURE

- Clamp the holder 110110 for the injection valve in a vise.
- Place the top part of the injection holder into the holder 110110 and unscrew the union nut.

Sequence of disassembly:

1. Union nut
2. Injection nozzle
3. Intermediate piece
4. Pressure spindle
5. Compression spring
6. Shims
7. Nozzle body



- Adjust the pressure by fitting the correct shim. The thicker the shim, the higher the opening pressure will be. Re-assemble the injection valve. Tighten the union nut to a torque of 40 - 50 Nm. Check the injection valve with the nozzle tester.

CHECKING FOR LEAKS

- Dry the nozzle and nozzle holder - blow dry with an air jet.
- Slowly press the tester hand lever down until a pressure approx. 20 bar under the previously obtained opening pressure is reached.
- The nozzle does not leak if no drops of fuel show within 10 seconds.

If a drop of fuel leaks out, disassemble the injection valve and eliminate the leak by cleaning the injection nozzle. If this does not remedy the leak, renew the injection valve.

Do not rework the valve.

BUZZING AND JET TEST

- Shut off the compression tester pressure gauge.

The buzzing test is an audible test for determining if the needle is moving easily in the nozzle body. New injection nozzles have a different buzzing behaviour as opposed to used ones. Wear in the area of the needle seat lets the buzzing behaviour deteriorate. A nozzle that does not buzz despite cleaning must be replaced.

A used injection valve must buzz audibly if the hand lever is operated quickly and it must produce a finely atomized spray. The shape of the spray can vary greatly from that of a new injection valve.

INSTALLING THE INJECTION NOZZLE

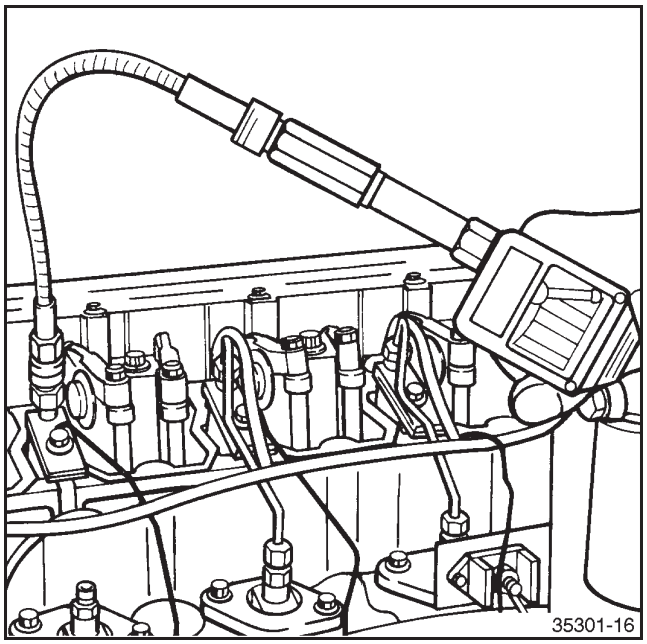
- Using some grease, slide the seal onto the injection valve.
- Insert the injection valve.
- Put the clamping shoe in place.
- Torque the screws to 16^{+5} N.

4.1.1.5 CHECKING THE COMPRESSION PRESSURE

- Remove the injection nozzle.
- Check the valve clearance.
- Insert and fasten connector 100110 along with the special seal.
- Connect a compressometer and crank the engine with the starter.

Specified pressure	28 - 33 bar
Max. difference in pressure	4 bar

NOTE: The measured compression pressure depends on the RPM of the starter when the measurement is carried out and on the altitude of the place the engine is operated in.
For this reason it is not possible to define exact limits. The compression pressure check is only recommended as a means of comparing all cylinders in relation to each other. If the difference in pressure exceeds 15 %, dismantle the appropriate cylinder unit and determine the cause.



4.1.1.6 CYLINDER HEAD

REMOVING THE CYLINDER HEAD

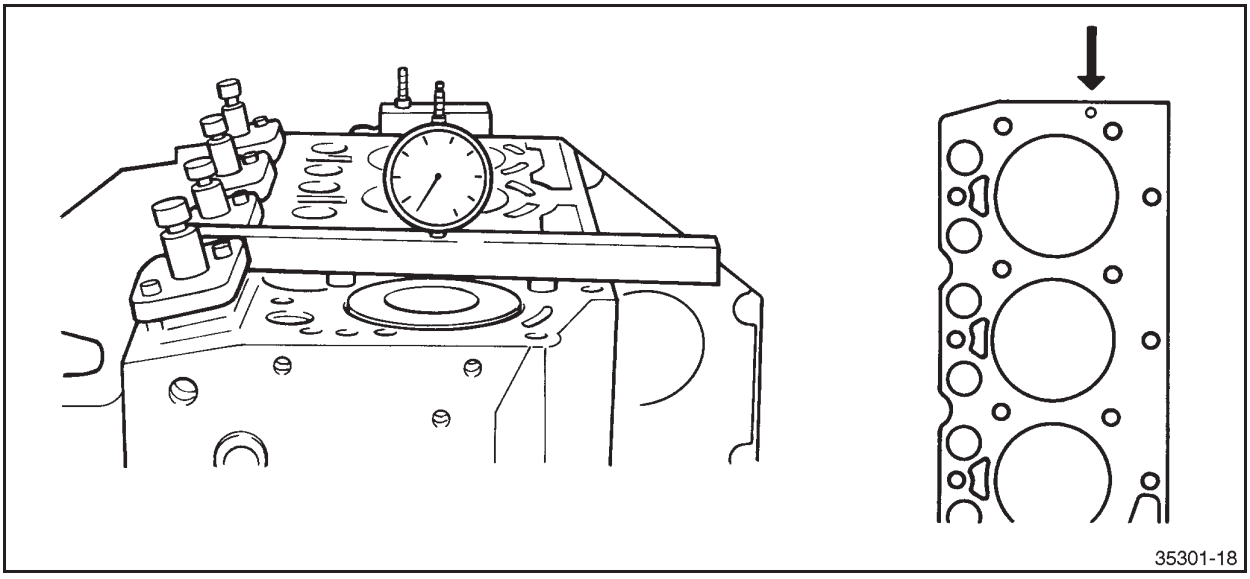
- With the engine cool, slacken the cylinder head bolts evenly and in steps in the reverse order as given in the schematic "Cylinder head bolt tightening sequence".

DETERMINING THE CYLINDER HEAD GASKET

NOTE: For the adjustment of the gap, there are 3 different cylinder head gaskets, which identifiable by holes.

- Place the dial gauge along with spacers 10075C on the sealing surface of the cylinder block and set the dial gauge to "0".
- Turn the piston to TDC and note the projecting length of the piston at the points of measurement.
- Select the correct cylinder head gasket according to the largest projecting length of the piston.

Projecting length of piston	Identification of cylinder head gasket
0.43 - < 0.64 mm	1 hole
0.64 - < 0.74 mm	2 holes
0.74 - 0.85 mm	3 holes



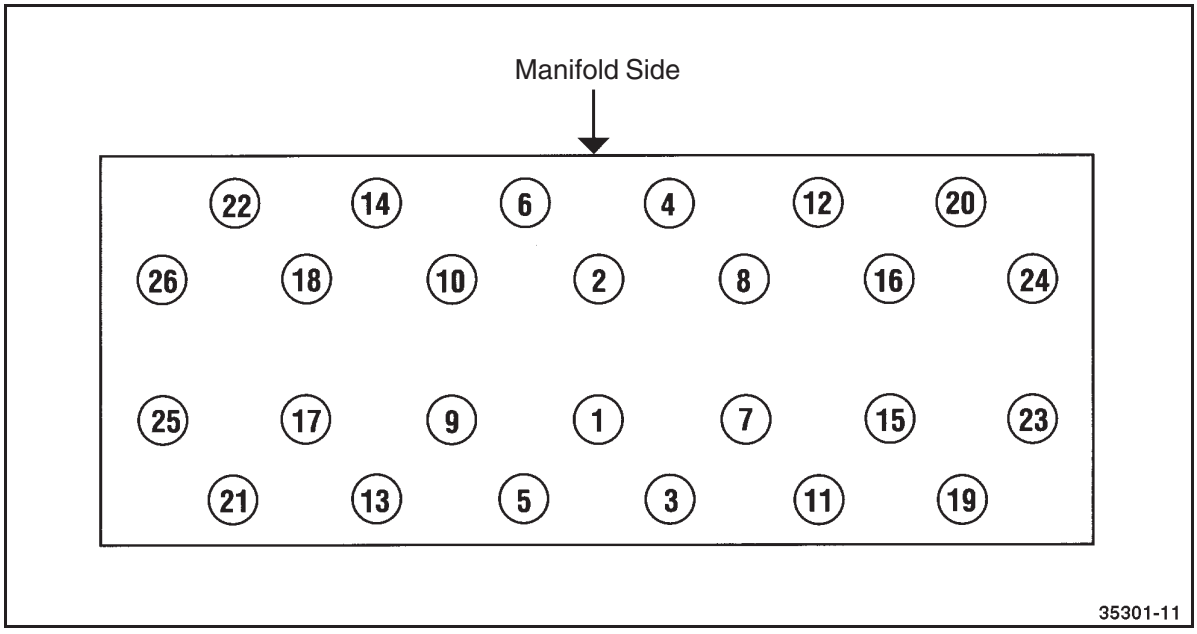
INSTALLING THE CYLINDER HEAD

NOTE: Sealing surfaces for cylinder head gaskets must be clean and free of oil. Pay attention to the fitting sleeve.

- Check the cylinder head for warping.
- Put the cylinder head in place.
- Check the cylinder head bolts for stretching, see "Visual check".
- Lightly the oil and screw in the cylinder head bolts.
  NOTE: Use the cylinder head bolts no more than 5 times.
- Insert the push rods.
- Mount the rocker arm bracket.
- Slightly oil and screw in the long cylinder head bolts.

- Torque the cylinder head bolts as specified and according to the tightening sequence.
  Pre-tightening: 1st step 30 Nm
  2nd step 80 Nm
  Retightening: 90°

CYLINDER HEAD BOLT TIGHTENING SEQUENCE



4.1.1.7 ADJUSTING THE BEGIN OF DELIVERY

If an injection pump must be replaced, the begin of delivery must be re-adjusted by determining the shim thickness anew.

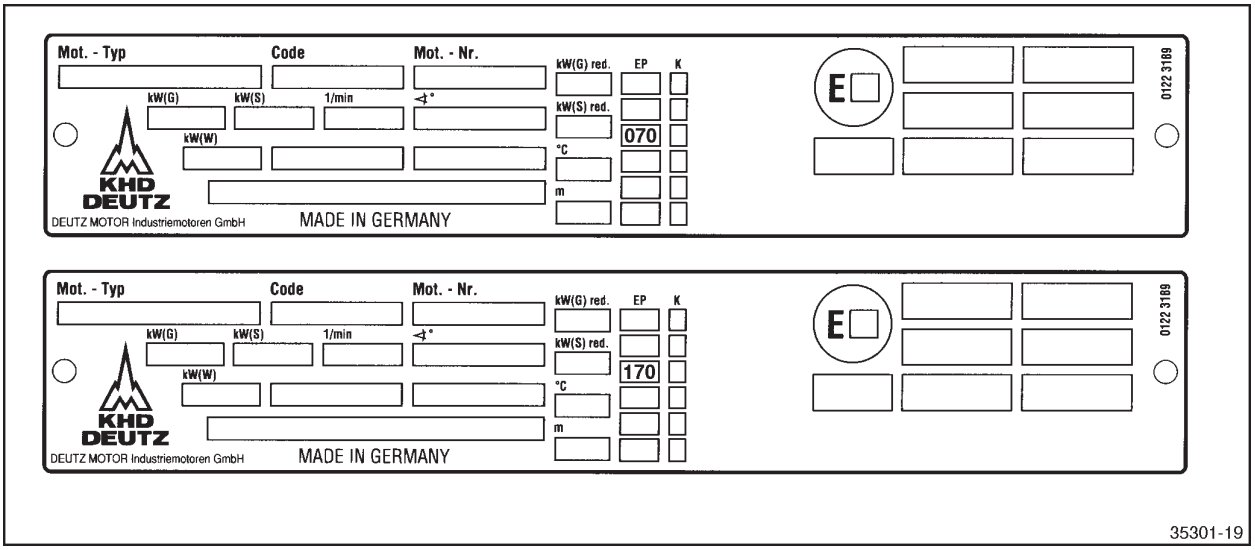
DETERMINING THE SHIM THICKNESS

The old injection pump and shim are not required for this procedure.

NOTE: From 4/95, the mounting depth of the injection pump has been increased by 10 mm so that the EP code changes from 70 to 170 and the basic dimension L_0 of the injection pump from 109 mm to 119 mm.
The metod of determining the thickness of the shims for the old versions remains the same.

Proceed as follows:

In the column marked "EP", read the EP code for cylinder 3 on the type plate on the rocker cover, e.g. 070 or 170 (reading sequence: line 1 = cylinder 1, line 2 = cylinder 2, etc.).



Take the corrected injection pump installation dimension (E_K) in Table 1a/1b according to the EP code, e.g. 111.725 mm.

Table 1a: EP code beginning with '0'

E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code
110.0		110.6		111.2	049	111.8	073	112.4	097
110.025		110.625		111.225	050	111.825	074	112.425	098
110.05		110.65		111.25	051	111.85	075	112.45	099
110.075		110.675		111.275	052	111.875	076	112.475	100
110.1		110.7		111.3	053	111.9	077	112.5	101
110.125		110.725		111.325	054	111.925	078	112.525	102
110.15		110.75	031	111.35	055	111.95	079	112.55	103
110.175		110.775	032	111.375	056	111.975	080	112.575	104
110.2		110.8	033	111.4	057	112.0	081	112.6	105
110.225		110.825	034	111.425	058	112.025	082	112.625	106
110.25		110.85	035	111.45	059	112.05	083	112.65	
110.275		110.875	036	111.475	060	112.075	084	112.675	
110.3		110.9	037	111.5	061	112.1	085	112.7	
110.325		110.925	038	111.525	062	112.125	086	112.725	
110.35		110.95	039	111.55	063	112.15	087	112.75	
110.375		110.975	040	111.575	064	112.175	088	112.775	
110.4		111.0	041	111.6	065	112.2	089	112.8	
110.425		111.025	042	111.625	066	112.225	090	112.825	
110.45		111.05	043	111.65	067	112.25	091	112.85	
110.475		111.075	044	111.675	068	112.275	092	112.875	
110.5		111.1	045	111.7	069	112.3	093	112.9	
110.525		111.125	046	111.725	070	112.325	094	112.925	
110.55		111.15	047	111.75	071	112.35	095	112.95	
110.575		111.175	048	111.775	072	112.375	096	112.975	

Table 1b: EP code beginning with '1'

E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code	E_K (mm)	Code
120.0		120.6		121.2	149	121.8	173	122.4	197
120.025		120.625		121.225	150	121.825	174	122.425	198
120.05		120.65		121.25	151	121.85	175	122.45	199
120.075		120.675		121.275	152	121.875	176	122.475	200
120.1		120.7		121.3	153	121.9	177	122.5	201
120.125		120.725		121.325	154	121.925	178	122.525	202
120.15		120.75	131	121.35	155	121.95	179	122.55	203
120.175		120.775	132	121.375	156	121.975	180	122.575	204
120.2		120.8	133	121.4	157	122.0	181	122.6	205
120.225		120.825	134	121.425	158	122.025	182	122.625	206
120.25		120.85	135	121.45	159	122.05	183	122.65	
120.275		120.875	136	121.475	160	122.075	184	122.675	
120.3		120.9	137	121.5	161	122.1	185	122.7	
120.325		120.925	138	121.525	162	122.125	186	122.725	
120.35		120.95	139	121.55	163	122.15	187	122.75	
120.375		120.975	140	121.575	164	122.175	188	122.775	
120.4		121.0	141	121.6	165	122.2	189	122.8	
120.425		121.025	142	121.625	166	122.225	190	122.825	
120.45		121.05	143	121.65	167	122.25	191	122.85	
120.475		121.075	144	121.675	168	122.275	192	122.875	
120.5		121.1	145	121.7	169	122.3	193	122.9	
120.525		121.125	146	121.725	170	122.325	194	122.925	
120.55		121.15	147	121.75	171	122.35	195	122.95	
120.575		121.175	148	121.775	172	122.375	196	122.975	

Read the code for the injection pump length (A) on the new injection pump, e.g. 53.
The basic dimension of the injection pump (L_0) is 109/119 mm.

Determine the theoretical thickness of the shim (T_S).

$T_S = E_K - (L_0 + A/100)$

T_S = 111.725 mm - (109 mm + 53/100 mm) or T_S = 121.725 mm - (119 mm + 53/100 mm)

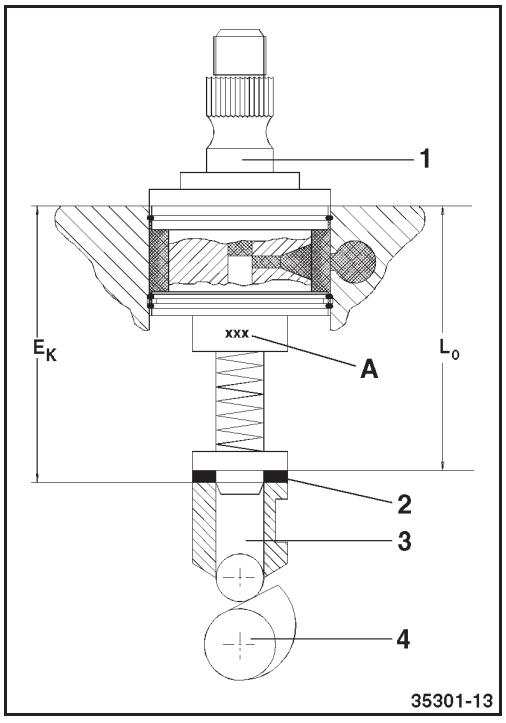
T_S = 2.195 mm

Choose the thickness of the shim (S_S) according to Table 2.

T_S 2.195 = **S_S 2.2 mm**

Table 2

Theor. Thickness "T_S" (mm)	Shim Thickness "S_S" (mm)	Theor. Thickness "Ts" (mm)	Shim Thickness "S_S" (mm)
0.95 - 1.049	1.0	2.45 - 2.549	2.5
1.05 - 1.149	1.1	2.55 - 2.649	2.6
1.15 - 1.249	1.2	2.65 - 2.749	2.7
1.25 - 1.349	1.3	2.75 - 2.849	2.8
1.35 - 1.449	1.4	2.85 - 2.949	2.9
1.45 - 1.549	1.5	2.95 - 3.049	3.0
1.55 - 1.649	1.6	3.05 - 3.149	3.1
1.65 - 1.749	1.7	3.15 - 3.249	3.2
1.75 - 1.849	1.8	3.25 - 3.349	3.3
1.85 - 1.949	1.9	3.35 - 3.449	3.4
1.95 - 2.049	2.0	3.45 - 3.549	3.5
2.05 - 2.149	2.1	3.55 - 3.649	3.6
2.15 - 2.249	2.2	3.65 - 3.749	3.7
2.25 - 2.349	2.3	3.75 - 3.850	3.8
2.35 - 2.449	2.4		



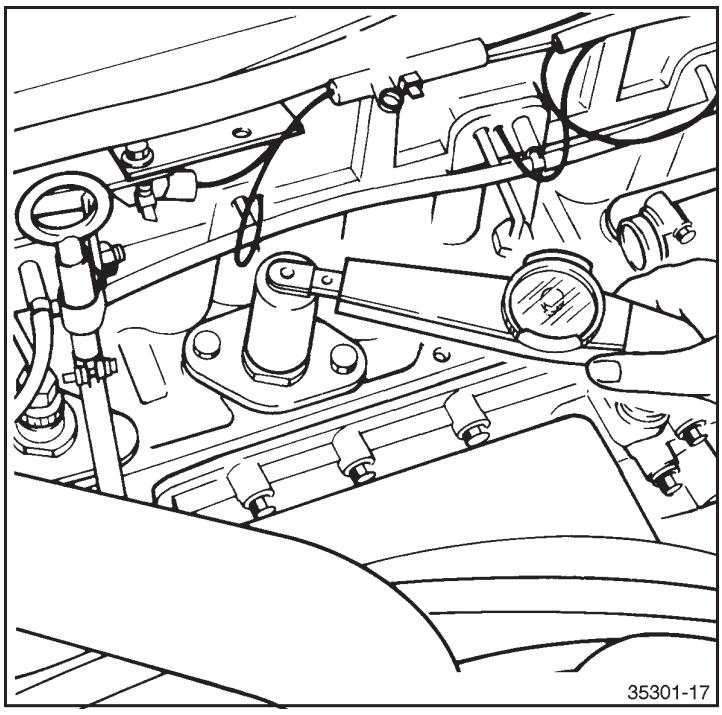
1 Injection pump
2 Shim thickness S_S
3 Roller shaft
4 Camshaft on base circle
A Code
E_K Installation dimension
L_0 Basic dimension 109/119 mm

INSTALLING THE INJECTION PUMP

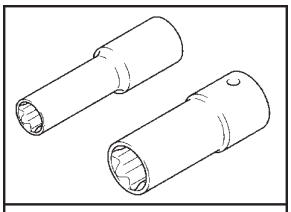
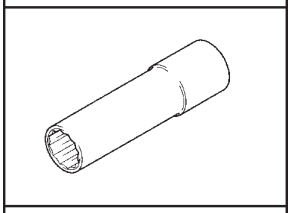
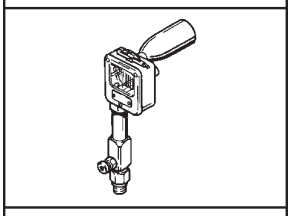
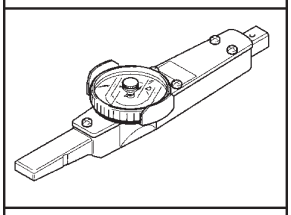
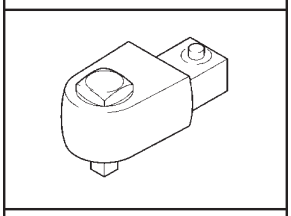
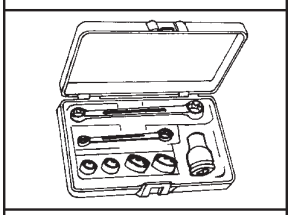
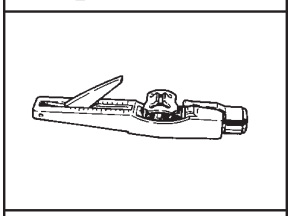
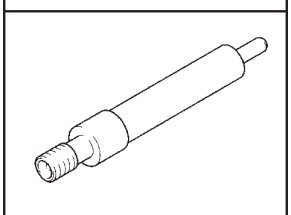
- Place the required shim (2) on the roller shaft.
- Turn the injection pump control lever to the stop position.
- Set the roller shaft (3) on the base circle.
- Slightly oil the O-ring and the hole for the ring.
- Remove the shut-off solenoid and replace by device 100830.
  Bring the control rod to the stop position with device 100800 and lock it in this position.
- Insert the injection pump (1).
- Install the flange and tighten the bolts evenly to a torque of 5 Nm.
- Loosen the bolts by 60 °.
- Using socket head 110460 and the torque spanner, turn the injection pump several times clockwise and anti-clockwise by 5 ° to 15 ° and determine the average friction torque (RM), e.g. 4.8 Nm.
- Turn the injection pump anti-clockwise as far as the stop with an average friction torque (RM) of 4.8 Nm + 1 Nm = 5.8 Nm and hold it in place.
  Tighten the flange bolts alternately to a torque of 7 Nm, 10 Nm and 30 Nm.
- Remove device 100830 and, using a screwdriver, check the control rod for ease of movement by sliding it back and forth.
- Reconnect the plug on the shut-off solenoid and switch on the ignition.
- Install the shut-off solenoid with a new seal.

NOTE: Oil the seal lightly.
Tighten the screws to a torque of 21 Nm.

NOTE: The shut-off solenoid must click when the ignition is switched on and off.

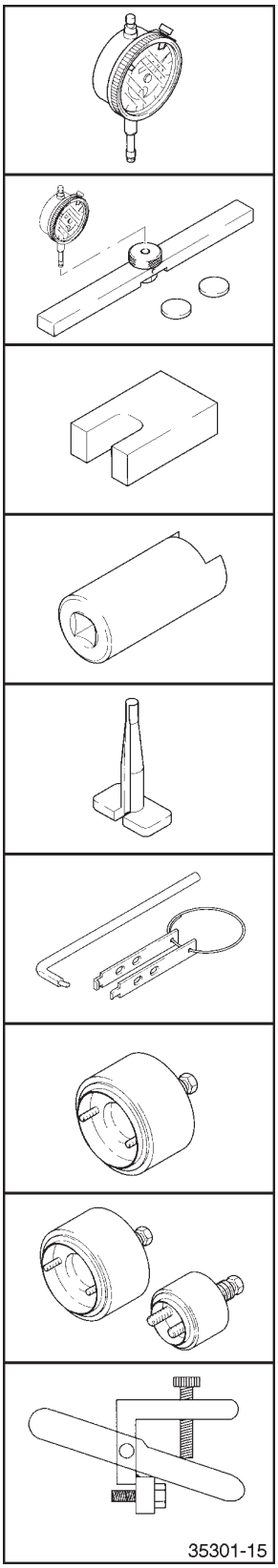


4.1.8 SPECIAL TOOLS

E 14 E 20	Torx socket heads, long version	
51	Socket head, 15 mm, long version for injection valve (union nut)	
2461	Compression pressure tester	
7532	Torque spanner	
7773 A	Socket spanner 1/4 "	
8189	Torx tool kit	
91 107	V-belt tension gauge	
100 110	Connector for compression pressure tester	

35301-14

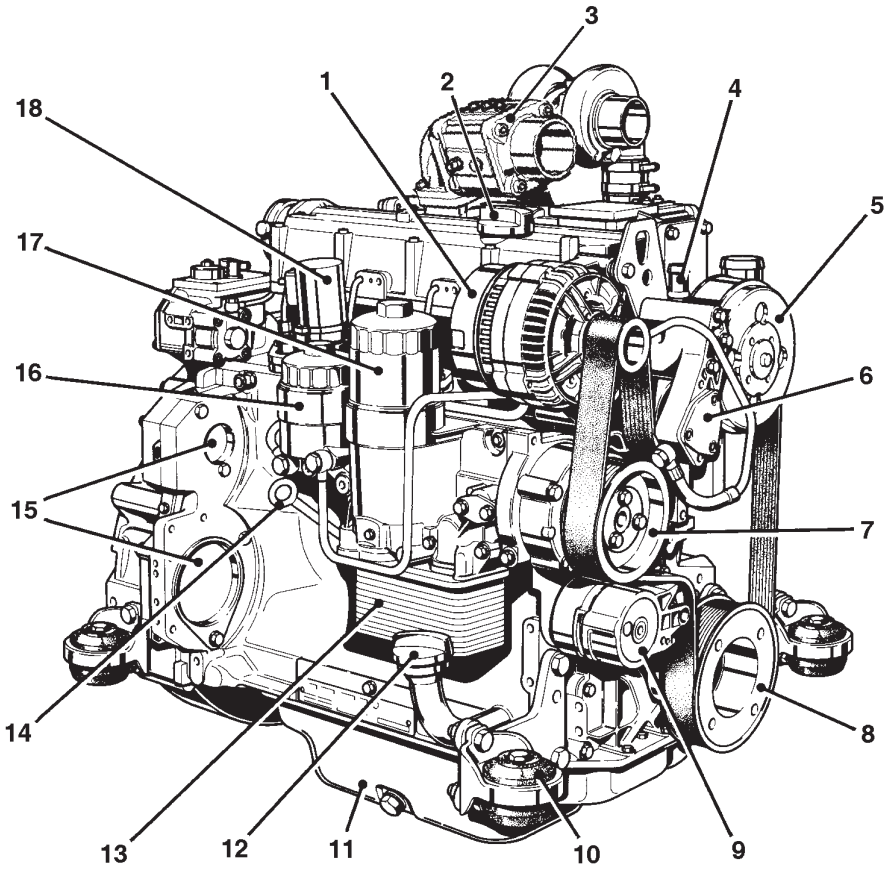
100 400	Dial gauge M2T with locking ring
100 750	Dial gauge with spacers for measuring TDC and projecting length of piston
110 110	Holder for injection valve, 11 mm
110 460	Socket head for turning the injection pump
114 010	Tool for connecting glow plug cables
142 710	Removal tool (hook) for crankshaft sealing rings
142 890	Assembly tool for rear crankshaft sealing ring
142 900	Assembly tool for crankshaft sealing ring
	Clamping device for control rod



Address your order for special tools to:
Fa. Wilbär, P.O. Box 14 05 80, D-42826 Remscheid

4.1.2 ENGINE MODEL BF6M 2012

4.1.2.1 OVERVIEW OF ENGINE COMPONENTS



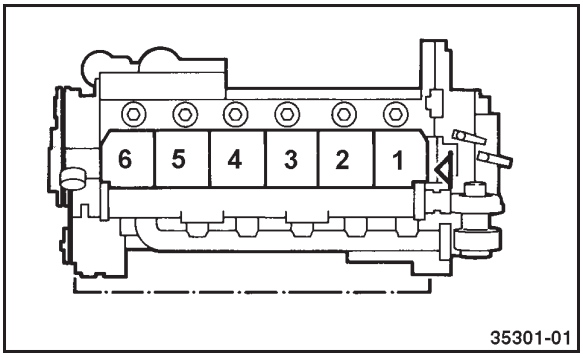
353_01-20

1 Generator
2 Oil filler hole
3 Heater flange
4 Coolant connection-recovery line
5 Fan pulley
6 Fuel lift pump
7 Coolant pump
8 V-belt pulley on crankshaft
9 Belt tensioner pulley
10 Mounting legs
11 Oil pan
12 Oil filling nozzle
13 Öil filter casing with engine oil cooler
14 Oil level dipstick
15 Provisions for attaching a compressor or hydraulic pump
16 Fuel filter cartridge
17 Öil filter cartridge
18 Lifting magnet

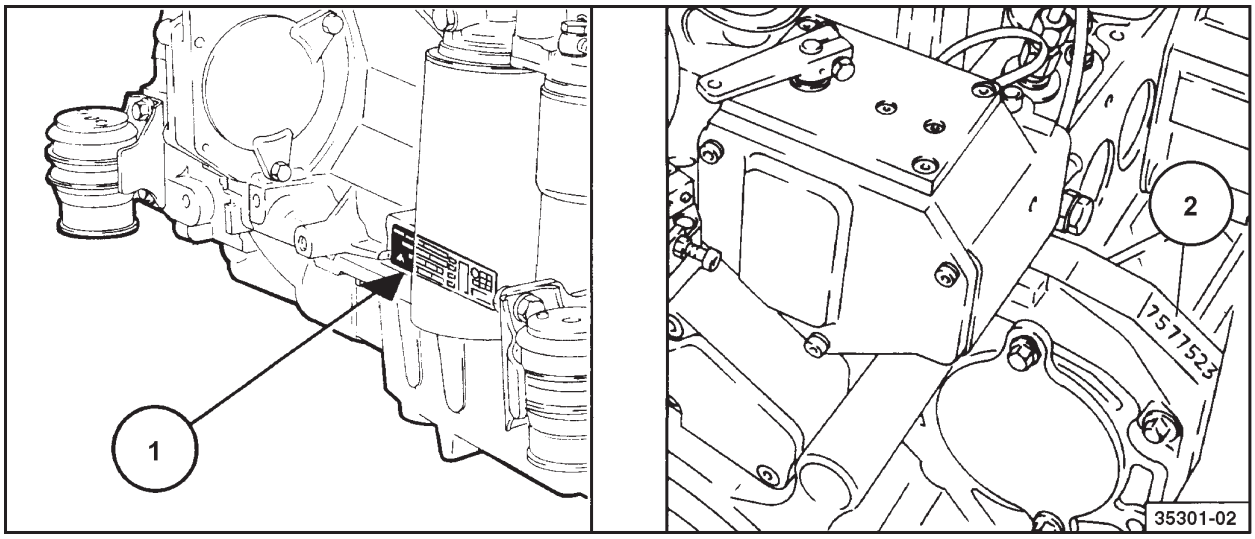
4.1.2.2 ENGINE SPECIFICATIONS

Engine model	BF6M 2012 E
Displacement	6060 cc
Power	74.9 kW at 2200 rpm
Opening pressure of injection valve	260 bar
Compression ratio	19 : 1
Compression	30 - 38 bar
Maximum difference in pressure	4 bar
Firing order	1 - 5 - 3 - 6 - 2 - 4
Valve clearance (cold)	inlet: $0{,}3^{+0{,}1}$ mm
	outlet: $0{,}5^{+0{,}1}$ mm
Lower idling speed	800 rpm
Upper idling speed	2300^{+50} rpm
Oil pressure at lower idling speed and 125 °C oil temperature	min. 0,8 bar

Count the cylinders beginning at the flywheel end.



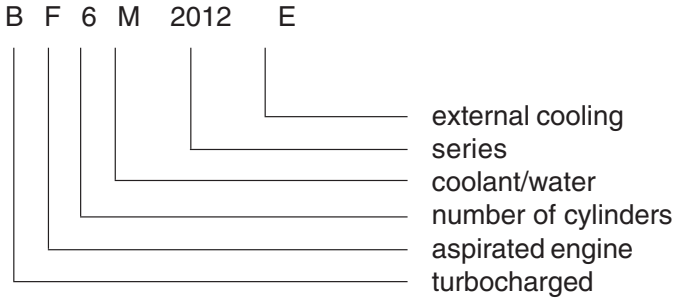
4.1.2.2.1 EXPLANATION OF THE ENGINE NUMBER



1 Manufacturer's plate with type and engine number
2 Engine number stamped on the crankcase

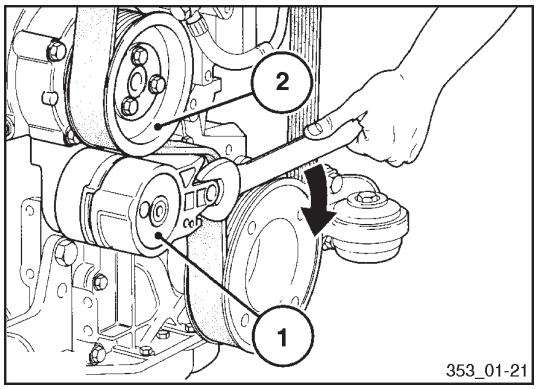
NOTE: A second type plate was affixed to the cylinder head cover by Linde.

EXPLANATION OF THE ENGINE NUMBER



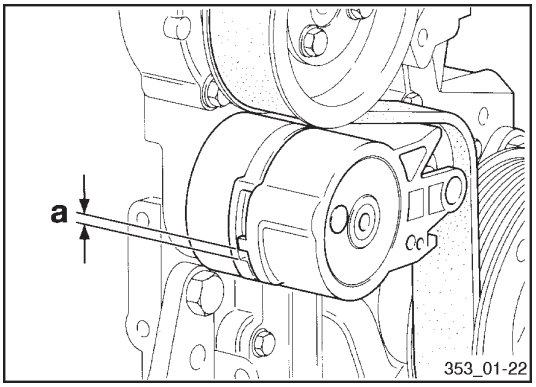
4.1.2.3 REPLACEMENT OF V-RIPPED BELT

Fit the V-ripped belt and tension it.
Pressh the belt tensioner pulley (1) in direction of the arrow. Fit the V-ripped belt, and finally place it on pulley (2). Loosen the belt tensioner pulley in opposite direction to the arrow until the V-ripped belt is tensioned.



If the V-ripped belt is used again, make sure to observe the wear limit.
Measure the distance "a" between the lug of the movable tensioning arm and the stop of the fixed tensioner housing. If the distance "a" is less than 3 mm, the V-ripped belt must be replaced.

The V-ripped belt is equipped with a spring-loaded belt tensioner pulley that tensions automatically, and it is not re-tightened.



4.1.2.4 ADJUSTING VALVE CLEARANCE

The adjustment can be carried out when the engine is cool or warm after a cooling period of at least 30 minutes (oil temperature < 80 °C).

Valve clearance: Inlet 0.3 $^{+0.1}$ mm
Outlet 0.5 $^{+0.1}$ mm

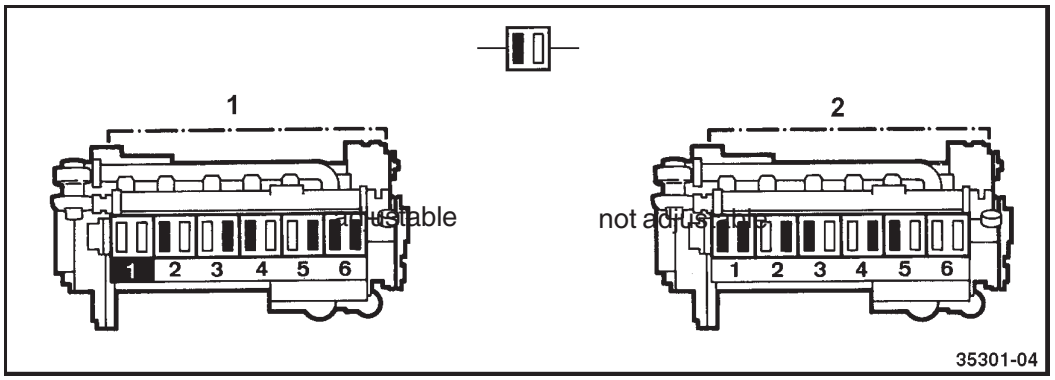
VALVE CLEARANCE SCHEMATIC

Crankshaft position 1

Turn the engine until the valve inlet and outlet of cylinder 1 are just open.

Crankshaft position 2

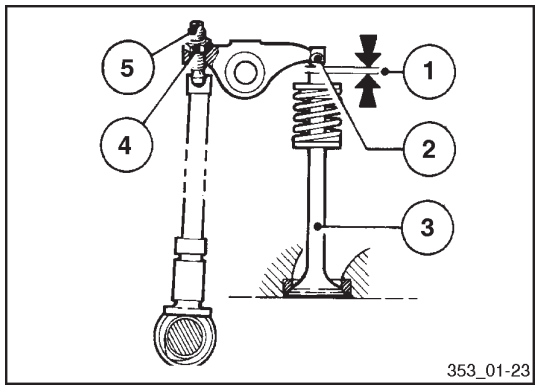
Turn the engine one full revolution (360 °).



NOTE: When a new rocker cover is installed, increase the valve clearance by 0.1 mm. Adjust the valve clearance to normal values after 50 service hours.

ADJUST & CHECK THE VALVE CLEARANCE

- Unscrew the venting valve and swivel it to the side.
- Dismount the cylinder head cover.
- Crankshaft position as shown in adjusting diagram.
- Prior to a valve clearance adjustment the motor must have cooled down for at least 30 minutes: Oil temperature less than 80 °C.
- Check the valve clearance (1) between the rocker cog (2) and the valve (3) with feeler gauge (6) (Gauge must overcome slight resistance to be slid in).
  For permissible valve clearance see above.



Tighten locknut: Demand value: 20 ±2 Nm

4.1.2.5 CHECKING AND ADJUSTING LEAK-FUEL-FREE INJECTION NOZZLES

CHECKING THE OPENING PRESSURE

NOTE: Use only test oil acc. to ISO 4113 or diesel fuel for the test.

CAUTION: When checking injection nozzles, take care that the fuel jet does not hit the hands. Due to the high pressure, the fuel can penetrate the skin and cause severe injuries.

- Install the injection nozzle on the nozzle tester.
- Press the lever down slowly. Read the pressure at the start of fuel ejection and adjust the pressure, if necessary, by changing the shims.

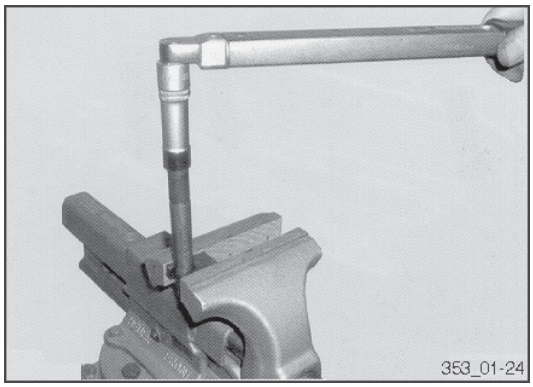
NOTE: After checking and adjustment, the pressure in the spring chamber in the injection nozzle must be reduced to zero before the injection nozzles are installed in the engine, in order to prevent possible starting difficulties of the engine.

CAUTION! During the checking procedure, the tension nut must only be unscrewed and re-tightened according to tightening instructions. Disassembling of the leakage fuel free injection nozzle is not permitted during the warranty period.

CHECK INJECTORS

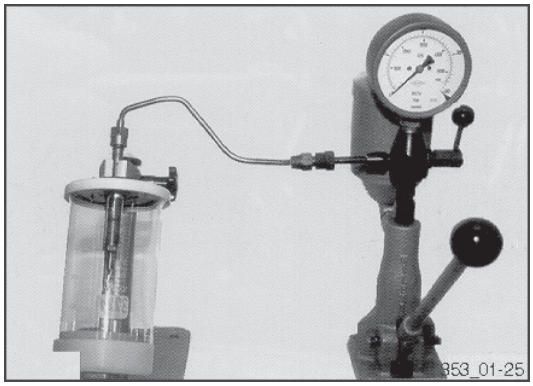
The injectors are not equipped with bores for leak -off fuel. The surplus fuel cannot be discharged and accumulates in the space above the injector needle in the area of the spring of the injector holder. Actuation of the manual lever of the injector tester is no longer possible in this case.
For relieving the pressure in the area of the spring, slacken the tensioning nut before each test and re-tighten to the specified torque after the test.

- Slacken tensioning nut by approx. 180° and re-tighten.
  Use dolly 110 110 for injector.
  Specified tightening torque: 30 - 40 Nm



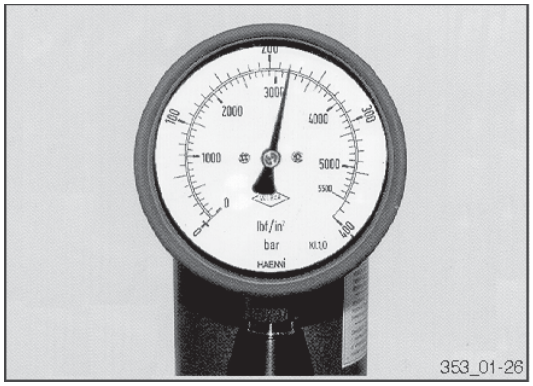
- Connect injector to nozzle tester 8008.

Caution
Beware of injection nozzle jet. The fuel penetrates deeply into the skin and may cause blood poisoning.



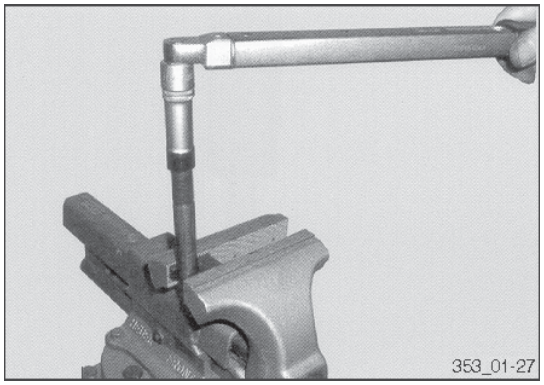
- With pressure gauge switched-on, slowly press lever of nozzle tester 8008 down.
  The pressure at which the gauge pointer stops or suddenly drops is the opening pressure.
  Opening pressure: 220 bar

NOTE: The pressure will build-up again in the area of the spring after approx. 3 - 4 strokes. Slacken the tensioning nut once again, re-tighten to specified tightening torque and repeat the test.



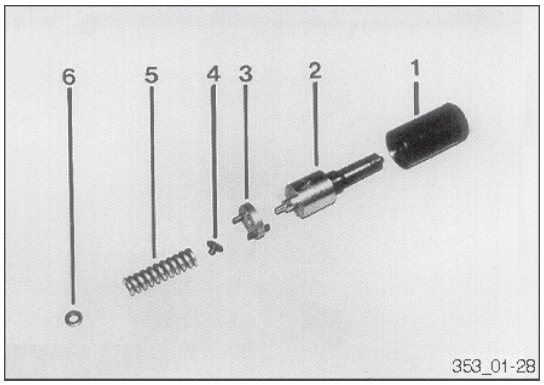
SETTING OF INJECTORS

For a correction of the opening pressure:
- Remove injector from nozzle tester 8008. Remove tensioning nut and uninstall all components. Use dolly 110 110 for the injector.



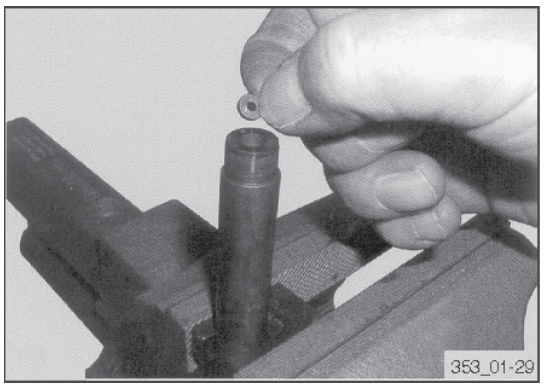
Sequence of parts disassembly and re-assembly

1. Tensioning nut
2. Nozzle
3. Adapter
4. Thrust pin
5. Compression spring
6. Shim



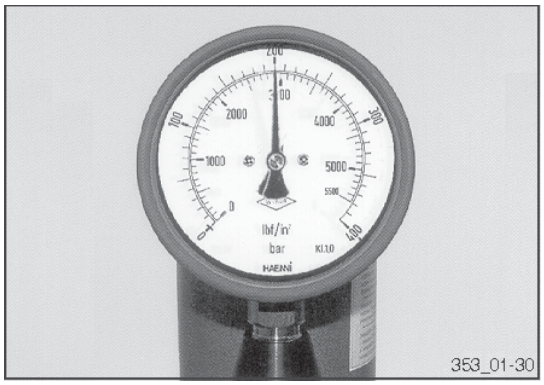
- Adjust opening pressure by selecting appropriate shim. A thicker shim will increase the opening pressure. Re-assemble injector. Tighten tensioning nut.
  Specified tightening torque: 30 - 40 Nm

- Check injector on nozzle tester 8008 once again.

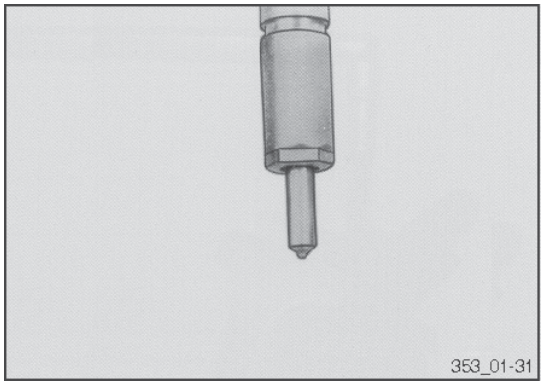


LEAK TEST

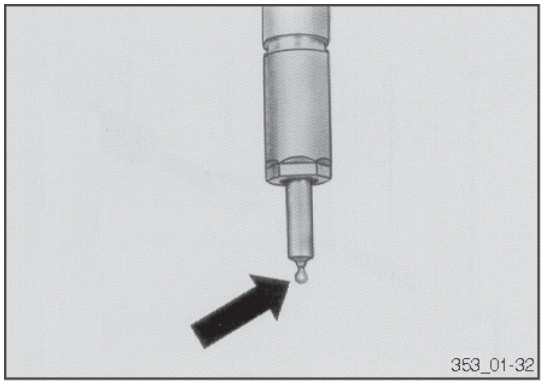
- Dry nozzle and nozzle holder by compressed air.
- Press hand lever of tester slowly down until apressure of approx. 20 bar below the previous opening pressure reading is attained.



- The nozzle is leak proof if there is no dripping within 10 seconds.

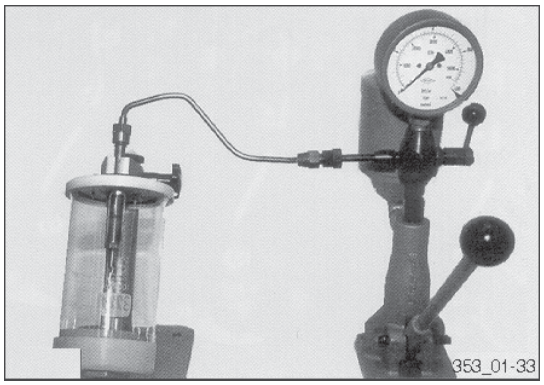


- If there is dripping, dismantle the injector and clean to remedy the leak. If this does not work, replace the nozzle by a new one.
- No reworking allowed!



BUZZING AND SPRAY PATTERN TEST

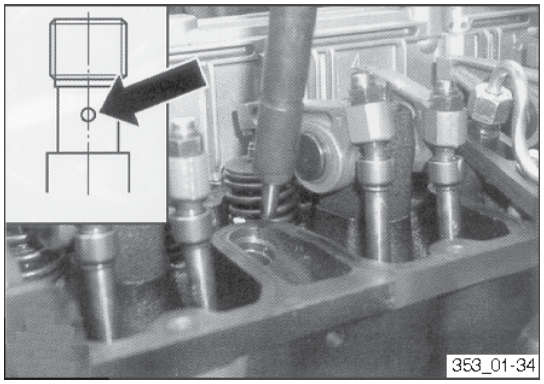
- Switch-off pressure gauge of tester.
- The buzzing test permits audible checking for ease of movement of the nozzle needle in the nozzle body. New injectors compared to used ones have a different buzzing sound.
- This buzzing sound deteriorates by wear in the area of the needle seat. If there is no buzzing of a nozzle despite cleaning, it must be replaced by a new one.
- A used injector must produce an audible buzzing sound upon rapid actuation of the hand lever and provide for a weil atomised spray pattern. The spray pattern may differ noticeably from that of a new injector.



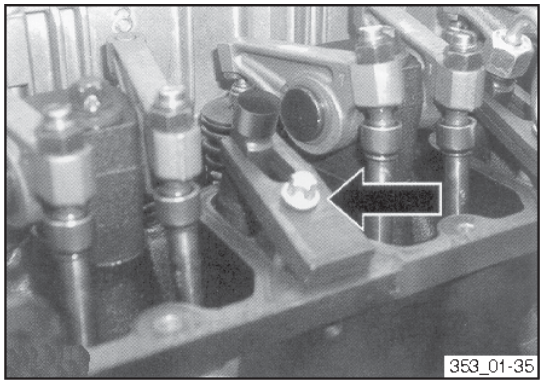
RE-INSTALLATION OF INJECTORS

- Place new slightly greased sealing rings onto injectors and install injectors.

NOTE: This notch on the injectors must face away from the claws.

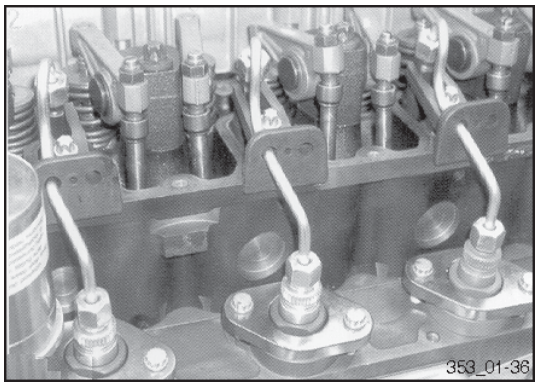


- Place claws in place and tighten bolts hand tight.

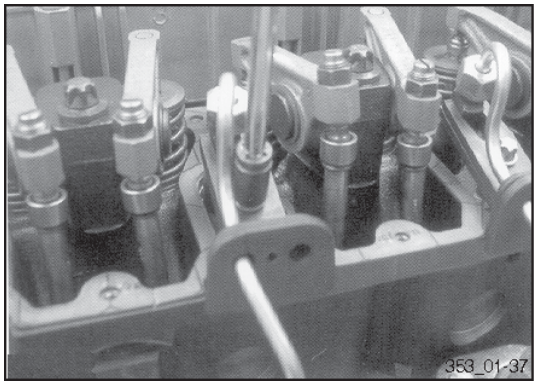


- Attach new injection lines with sealing rubber elements. Tighten cap screws finger-tight.

HINWEIS: When installing the injection lines make sure that sealing cones are exactly aligned one on top of the other.
Subsequent bending is not allowed. Injeetion lines must not be re-used.



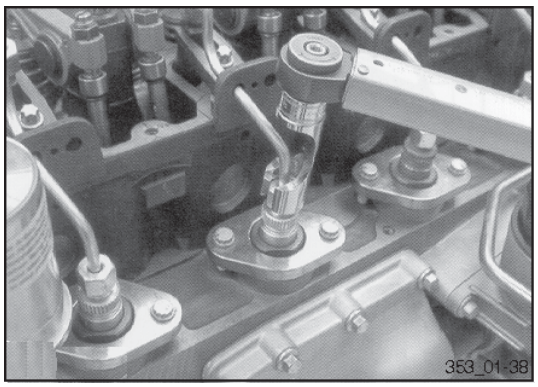
- Tighten bolts of claws.
  Specified tightening torque: 16 $^{+5}$ Nm



- Pre-tension cap nuts of injection lines on injection pumps and injection nozzles to a tightening torque of approx. 5 Nm. Then tighten cap nuts.

  Specified tightening torque: 25 $^{+3,5}$ Nm

NOTE: Use claw grip wrench 8018**.**

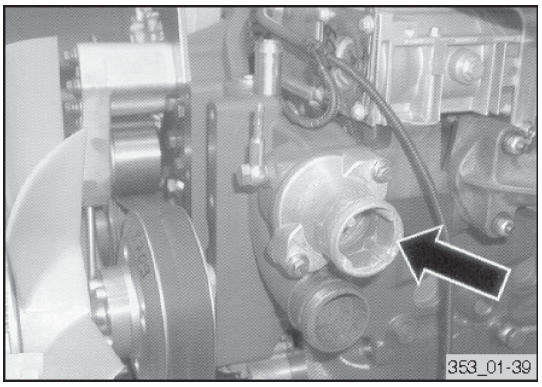


4.1.2.6 THERMOSTAT

REMOVAL

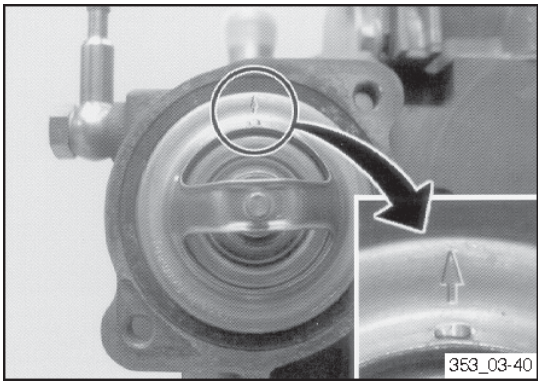
- Drain coolant, collect it, and dispose of it in accordance with legal standards.
- Dismantle outlet connecting piece. Remove thermostat.

NOTE: Collect coolant and dispose of it in accordance with legal standards.



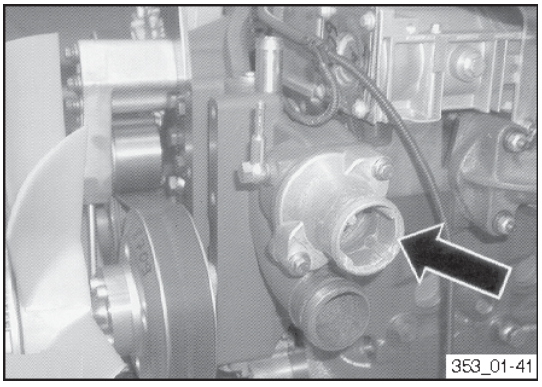
- Attach new sealing ring to thermostat. Insert thermostat together with new sealing ring.

NOTE: Mind operating position of thermostat. Arrow (venting notch) points to the top.



- Attach outlet connecting piece.

  Required tightening torque: 30 Nm

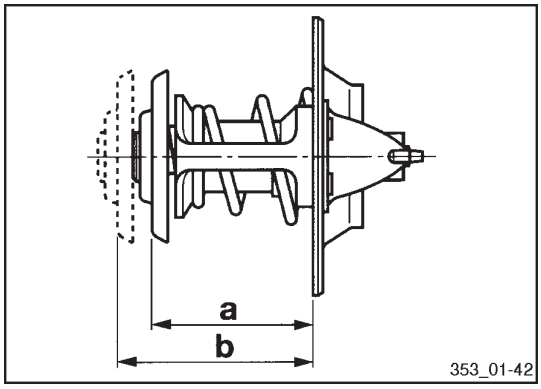


CHECKING

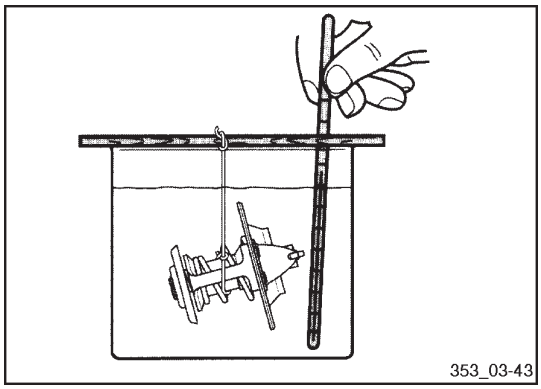
Check thermostat in removed condition.

- Measure dimension „a“ on the thermostat.

NOTE: „a“ = stroke beginning at approx. 83 ± 2°C (T1)
„b“ = stroke ending at approx. 95°C (T2)

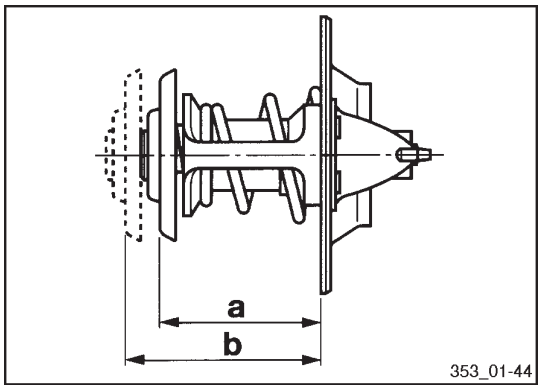


- Heat up thermostat in the water bath.
  For a determination of the exact opening point, the temperature reading should take place as closely as possible to the thermostat, however, without contacting the latter.
  The water must be continuously stirred to arrive at a uniform distribution of temperature. The rate of rise of temperature should not exceed 1°C/ min. at a maximum otherwise opening will be delayed correspondingly.



- Measure dimension „b“ on the thermostat.

Stroke length at indicated temperature (T2) 8 mm at aminimum.

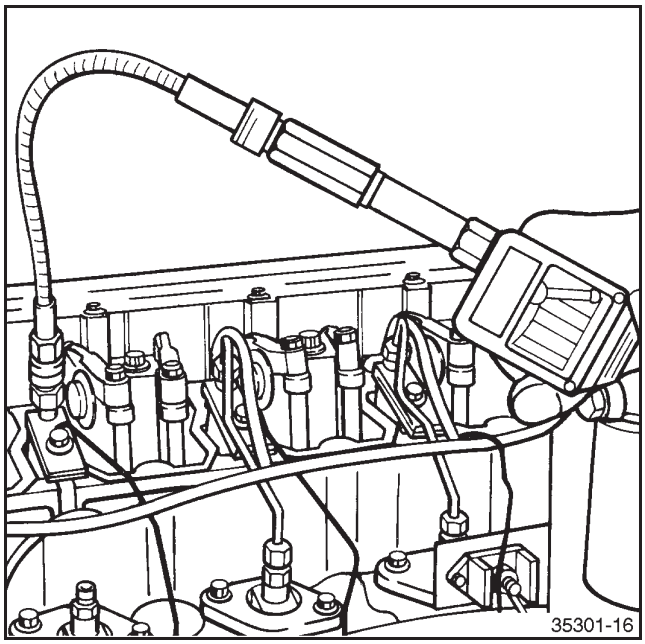


4.1.2.7 CHECKING THE COMPRESSION PRESSURE

- Remove the injection nozzle.
- Check the valve clearance.
- Insert and fasten connector 100110 along with the special seal.
- Connect a compressometer and crank the engine with the starter.

Specified pressure	30 - 38 bar
Max. difference in pressure	4 bar

NOTE: The measured compression pressure depends on the RPM of the starter when the measurement is carried out and on the altitude of the place the engine is operated in.
For this reason it is not possible to define exact limits. The compression pressure check is only recommended as a means of comparing all cylinders in relation to each other. If the difference in pressure exceeds 15 %, dismantle the appropriate cylinder unit and determine the cause.



4.1.2.8 CYLINDER HEAD

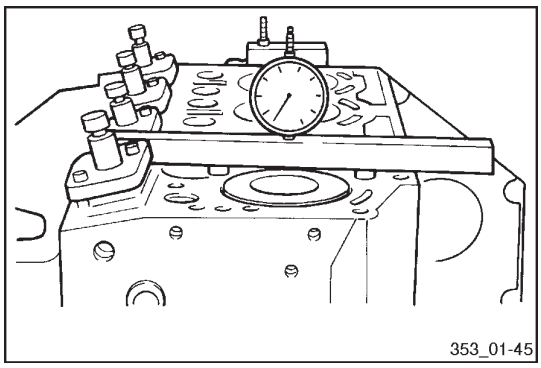
REMOVING THE CYLINDER HEAD

- With the engine cool, slacken the cylinder head bolts evenly and in steps in the reverse order as given in the schematic "Cylinder head bolt tightening sequence".

DETERMINING THE CYLINDER HEAD GASKET

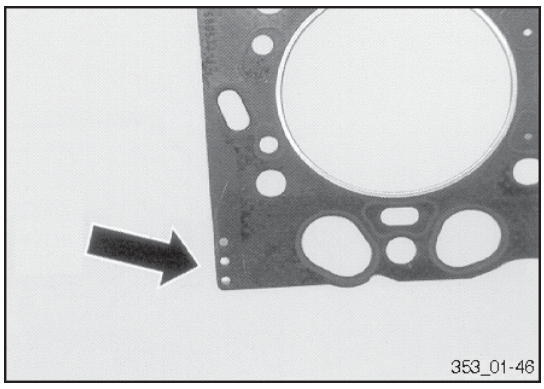
NOTE: For the adjustment of the gap, there are 3 different cylinder head gaskets, which identifiable by holes.

- Place the dial gauge along with spacers 100750 on the sealing surface of the cylinder block and set the dial gauge to "0".
- Turn the piston to TDC and note the projecting length of the piston at the points of measurement.



- Compare the largest value with the table and determine the corresponding cylinder head gasket.

Projecting length of piston	Identification of cylinder head gasket
0.33 - < 0.55 mm	1 hole
0.56 - < 0.65 mm	2 holes
0.66 - 0.76 mm	3 holes



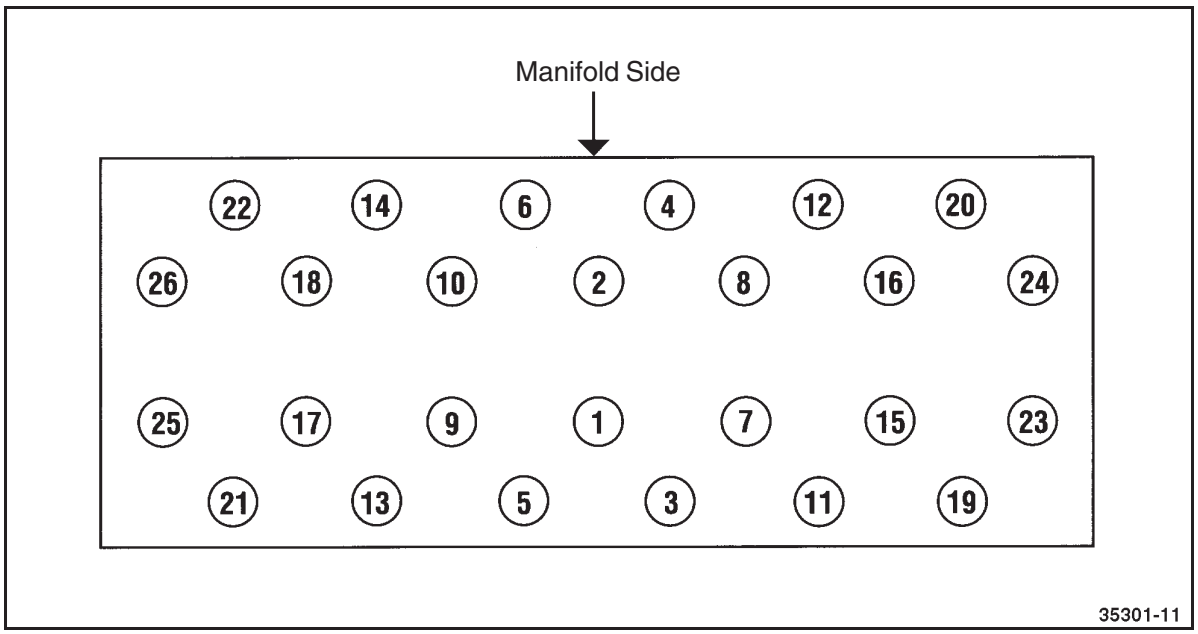
INSTALLING THE CYLINDER HEAD

NOTE: Sealing surfaces for cylinder head gaskets must be clean and free of oil. Pay attention to the fitting sleeve.

- Check the cylinder head for warping.
- Put the cylinder head in place.
- Check the cylinder head bolts for stretching, see "Visual check".
- Lightly the oil and screw in the cylinder head bolts.
  NOTE: Use the cylinder head bolts no more than 5 times.
- Insert the push rods.
- Mount the rocker arm bracket.
- Slightly oil and screw in the long cylinder head bolts.

- Torque the cylinder head bolts as specified and according to the tightening sequence.
  Pre-tightening: 1st step 30 Nm
  2nd step 80 Nm
  Retightening: 90°

CYLINDER HEAD BOLT TIGHTENING SEQUENCE



4.1.2.9 INJECTION PUMP

4.1.2.9.1 ADJUSTING THE BEGIN OF DELIVERY

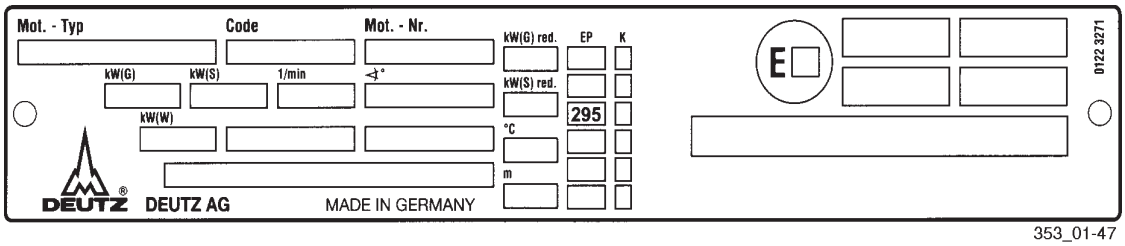
If an injection pump must be replaced, the begin of delivery must be re-adjusted by determining the shim thickness anew.

DETERMINING THE SHIM THICKNESS

The old injection pump and shim are not required for this procedure.

Proceed as follows:

In the column marked "EP", read the EP code for cylinder 3 on the name plate on the cylinder head cover, e.g. 070 (reading sequence: line 1 = cylinder 1, line 2 = cylinder 2, etc.).



Take the corrected injection pump installation dimension (E_K) in Table 1 according to the EP code, e.g. 120.875 mm.

Table 1

E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code
119,25	230	119,85	254	120,45	278	121,05	302
119,275	231	119,875	255	120,475	279	121,075	303
119,3	232	119,9	256	120,5	280	121,1	304
119,325	233	119,925	257	120,525	281	121,125	305
119,35	234	119,95	258	120,55	282	121,15	306
119,375	235	119,975	259	120,575	283	121,175	307
119,4	236	120,0	260	120,6	284	121,2	308
119,425	237	120,025	261	120,625	285	121,225	309
119,45	238	120,05	262	120,65	286	121,25	310
119,475	239	120,075	263	120,675	287	121,275	311
119,5	240	120,1	264	120,7	288	121,3	312
119,525	241	120,125	265	120,725	289	121,325	313
119,55	242	120,15	266	120,75	290	121,35	314
119,575	243	120,175	267	120,775	291	121,375	315
119,6	244	120,2	268	120,8	292		
119,625	245	120,225	269	120,825	293		
119,65	246	120,25	270	120,85	294		
119,675	247	120,275	271	120,875	295		
119,7	248	120,8	272	120,9	296		
119,725	249	120,825	273	120,925	297		
119,75	250	120,35	274	120,95	298		
119,775	251	120,375	275	120,975	299		
119,8	252	120,4	276	121,0	300		
119,825	253	120,425	277	121,025	301		

Read the code for the injection pump length (A) on the new injection pump, e.g. 42.

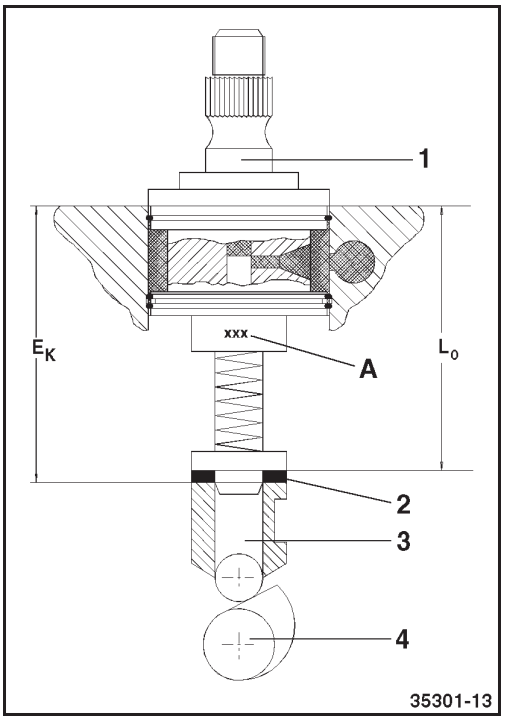
The basic dimension of the injection pump (L_0) is 117.5 mm.

Determine the theoretical thickness of the shim (T_S).

$T_S = E_K - (L_0 + A/100)$
$T_S = 120.875 \text{ mm} - (117.5 \text{ mm} + 42/100 \text{ mm})$
$T_S = 2.955 \text{ mm}$

Choose the thickness of the shim (S_S) according to Table 2.

T_S 2.955 = **S_S 3.0 mm**



1 Injection pump
2 Shim thickness S_S
3 Roller shaft
4 Camshaft on base circle
A Code
E_K Installation dimension
L_0 Basic dimension 117.5 mm

Table 2

Theor. Thickness "T_S" (mm)	Shim Thickness "S_S" (mm)	Theor. Thickness "Ts" (mm)	Shim Thickness "S_S" (mm)
0,95 - 1,049	1,0	2,45 - 2,549	2,5
1,05 - 1,149	1,1	2,55 - 2,649	2,6
1,15 - 1,249	1,2	2,65 - 2,749	2,7
1,25 - 1,349	1,3	2,75 - 2,849	2,8
1,35 - 1,449	1,4	2,85 - 2,949	2,9
1,45 - 1,549	1,5	2,95 - 3,049	3,0
1,55 - 1,649	1,6	3,05 - 3,149	3,1
1,65 - 1,749	1,7	3,15 - 3,249	3,2
1,75 - 1,849	1,8	3,25 - 3,349	3,3
1,85 - 1,949	1,9	3,35 - 3,449	3,4
1,95 - 2,049	2,0	3,45 - 3,549	3,5
2,05 - 2,149	2,1	3,55 - 3,649	3,6
2,15 - 2,249	2,2	3,65 - 3,749	3,7
2,25 - 2,349	2,3		
2,35 - 2,449	2,4		

4.1.2.9.2 REPLACEMENT OF THE INJECTION PUMP

This repair method is intended for a replacement of the injection pumps only.

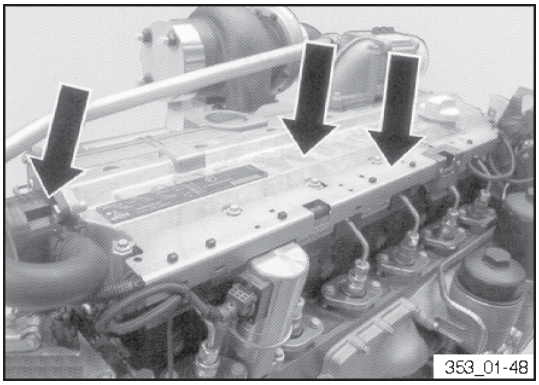
Commercially available tools:

Claw grip wrench	8018
Torx tool kit	8189

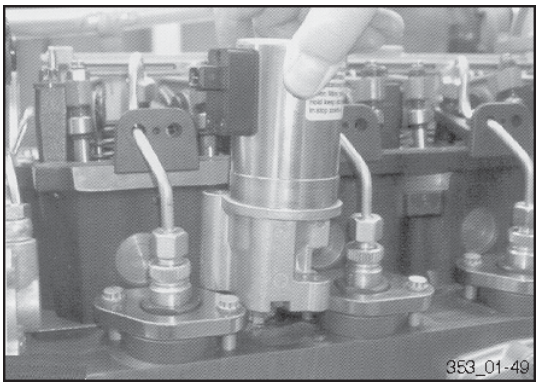
Special tools:

Press-on device for control rod	100 830
Extractor pulling device	150 800
Extractor pulling device for injection valve	110 030

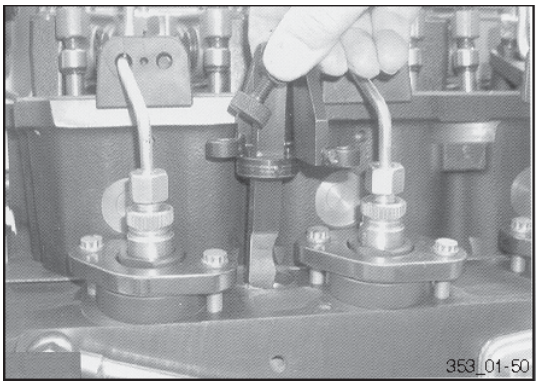
- Remove pressure control valve and inspection cover. Pull off cable connector from cut-off solenoid, governor and temperature sensor. Swivel holding plate sideways.



- Remove engine cut-off device or lock cover.

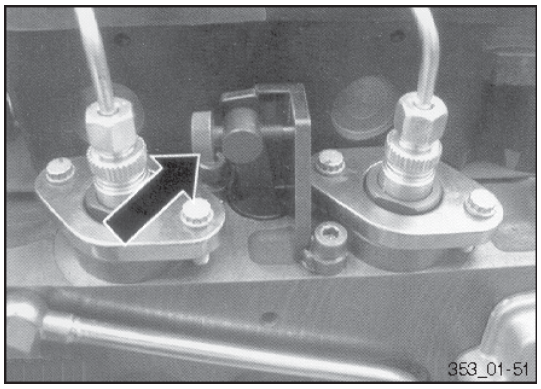


- Press control rod into stop position using the stop lever. Insert press-on device for control rod 100 830 and tighten by bolts.



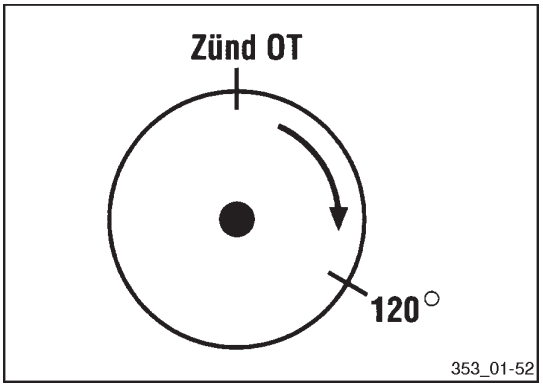
- Press control rod into stop position using the knurled lock bolt.
- Use press-on device for control rod 100 830.

NOTE: Tighten knurled lock bolt finger tight.



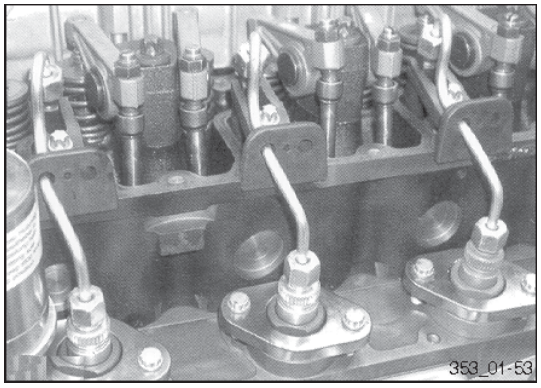
- Set cylinder of the injection pump to be removed to firing TCD.
- Turn crankshaft by approx. 120° opposite to the direction of rotation of the engine.
  (Zünd OT - firing TCD)

NOTE: As viewed in direction of the flywheel.

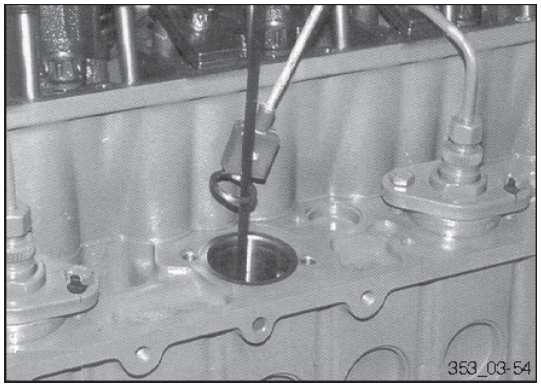


- Remove the corresponding injection line, injection pump and injection valve.

NOTE: Use claw grip wrench 8018 for the injection line.
Use extractor pulling device 150 800 with puller 110 030 for injection valve if jammed.
Pull out O-ring if necessary, using extractor 120 680.

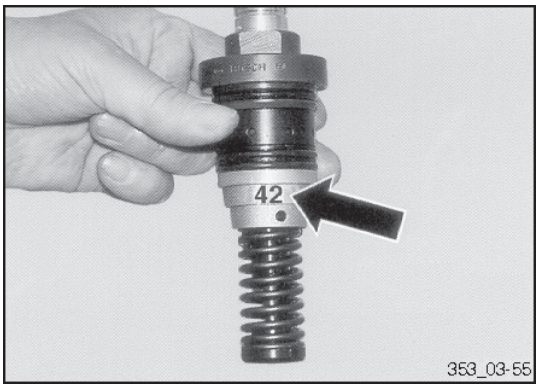


- Carefully extract shim with bar magnet..



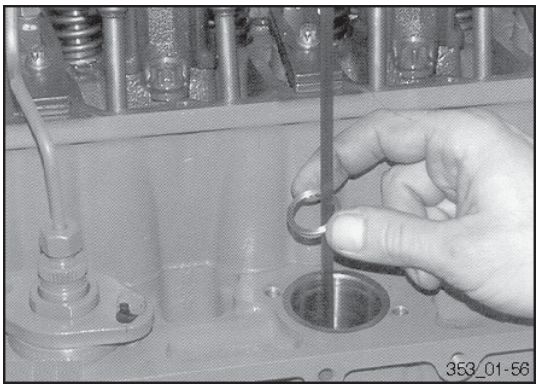
- Read off ID number for injection pump length (dimension A) for the new injection pump.

NOTE: Determining new shim.

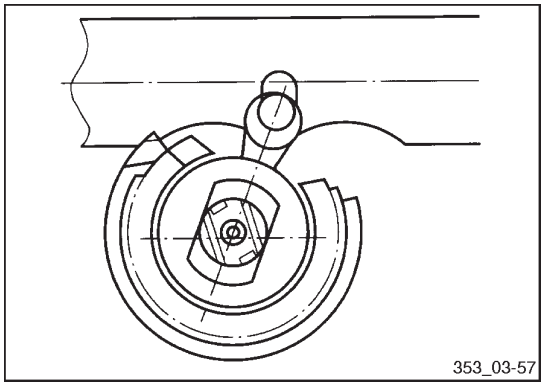


- Place newly determined shim on roller tappet

.

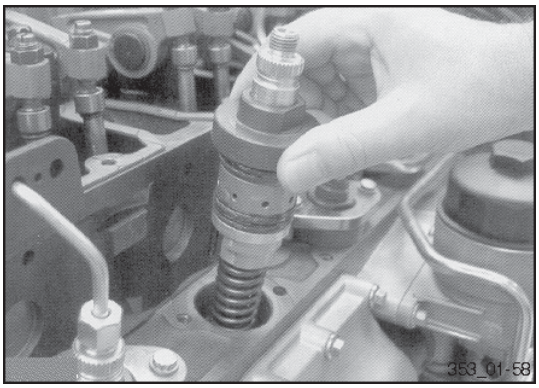


- Turn injection pump steering lever to center position more or less.



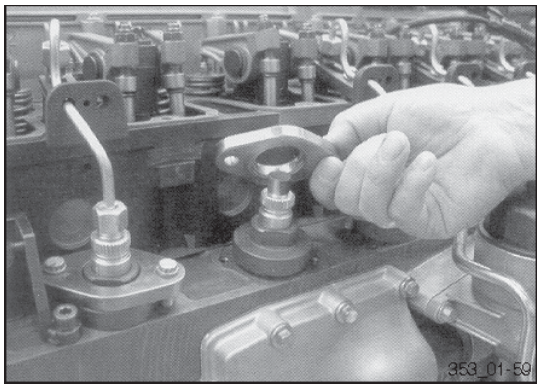
- Apply AP 1908 compound to location hole in crankcase and to O-rings of injection pump. Mount injection pump and insert injection pump steering lever carefully into control rod.

NOTE: The roller tappet for the respective injection pump must be on the base circle of the camshaft.

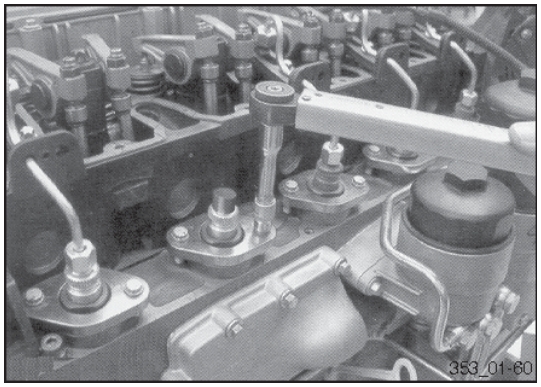


- Put on flange.

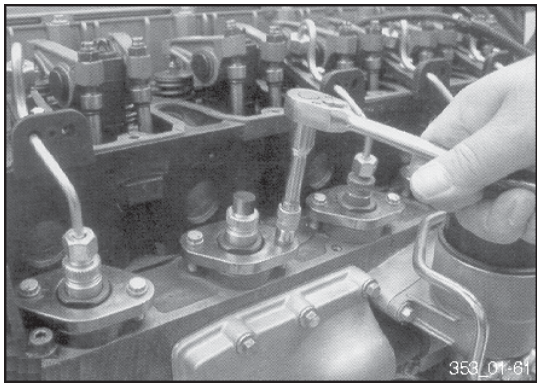
NOTE: Chamfered end must face injection pump body.



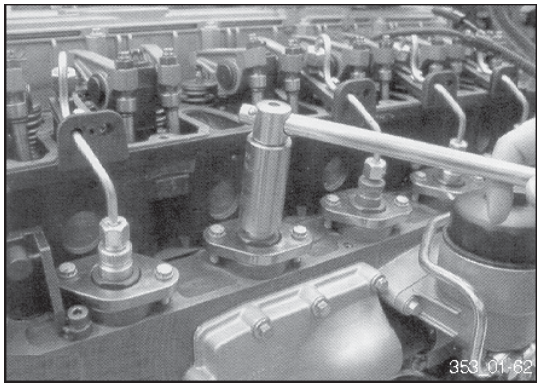
- Slightly oil bolts and tighten to a tightening torque of 5 Nm.



- Release bolts again by 60°.

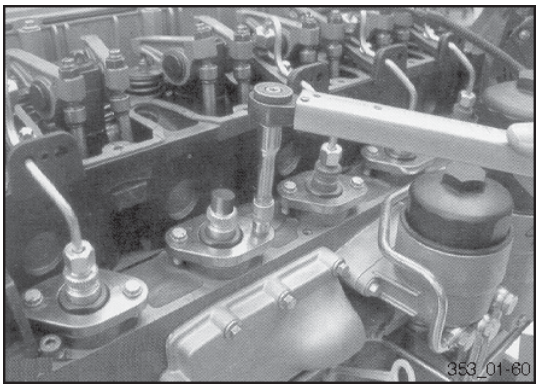


- Carefully turn injection pump counter clockwise up to a noticeable stop using serrated wrench 8117.



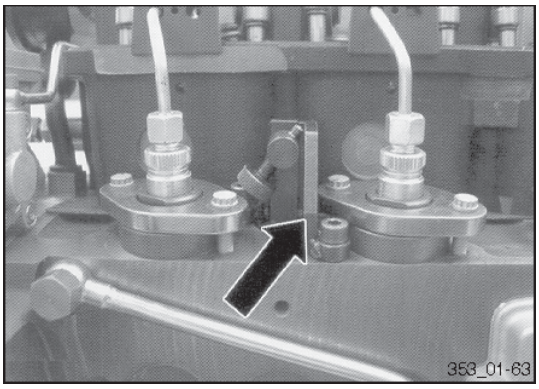
- Turn bolts in again by 60° and gradually tighten to a tightening torque of 7 Nm, 10 Nm and 30 Nm.

NOTE: Start with the outer boit remotest from flywheel.



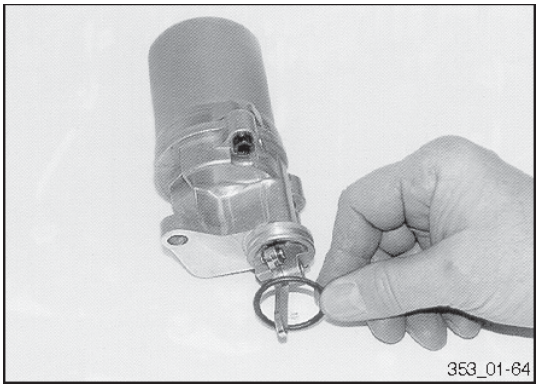
- Turn knurled lock bolt back again.
  Remove press on device 100 830.

NOTE: Check smooth movement of control rod from stop position to start position. Actuate cut-off lever to this end.



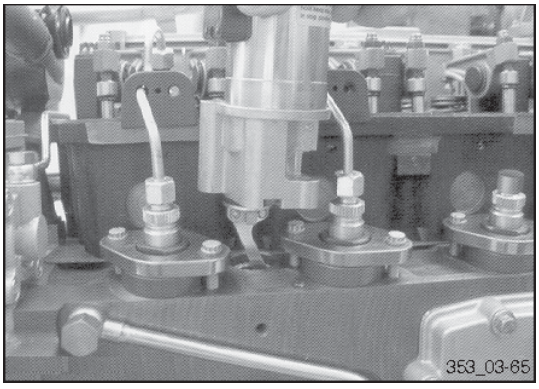
- Mount new O-ring.

NOTE: Slightly oil O-ring.



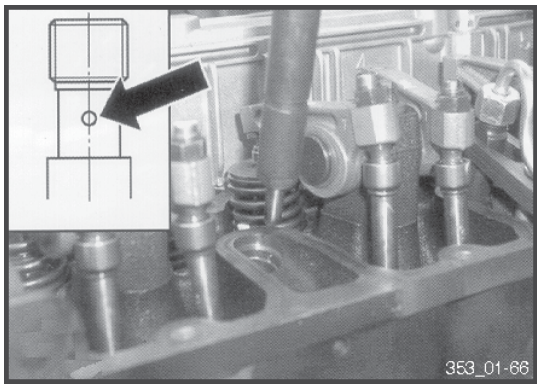
- Press control rod into stop position using the cut-off lever and retain.
- Install engine shut-off device. Tighten bolts. Plug in cable connector.

  Specified tightening torque: 21 Nm

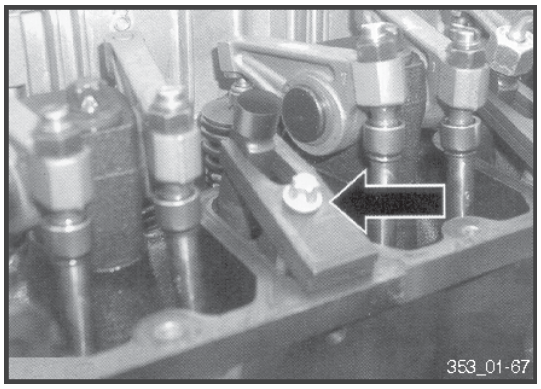


- Siide sealing ring onto injection valve using some grease and insert injection valve.

NOTE: The notch on the injection valve must face away from the claw. Marking faces exhaust gas end.

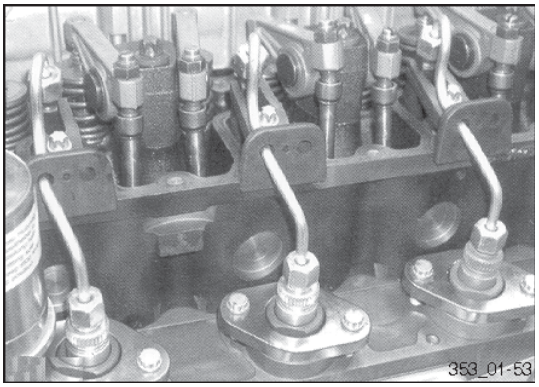


- Mount claws and tum in bolts loosely.



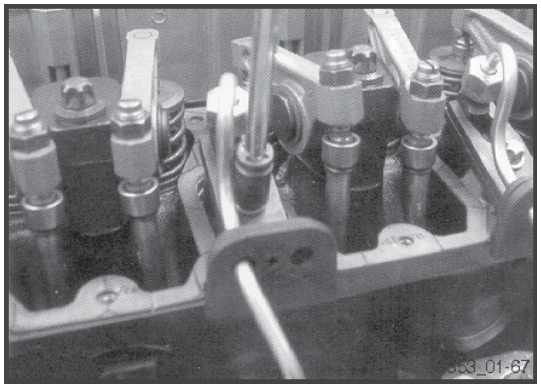
- Fit new injection line with sealing rubber. Tighten cap nut finger-tight.

NOTE: Sealing cones must be exactly in line when mounting the injection line.
Re-bending is not allowed. Injection lines must not be used twice.



- Tighten bolt of claws.

Specified tightening torque: 16 $^{+5}$ Nm

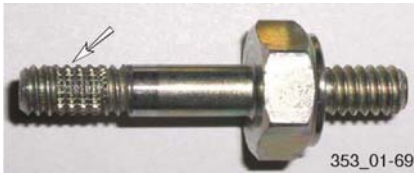


4.1.2.10 HEATER FLANGE

POSITIVE POLE SCREW OF HEATER FLANGE

Special screw TN 0425 8628

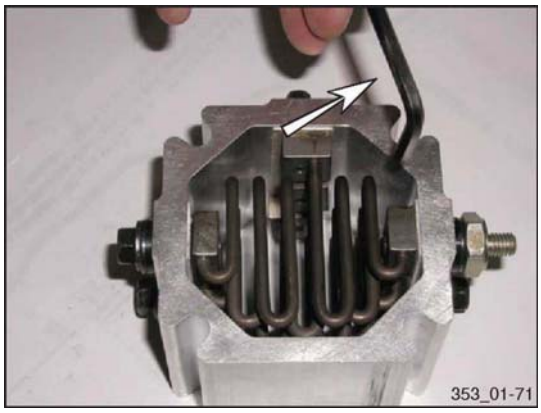
NOTE: This special screw must be used only once!

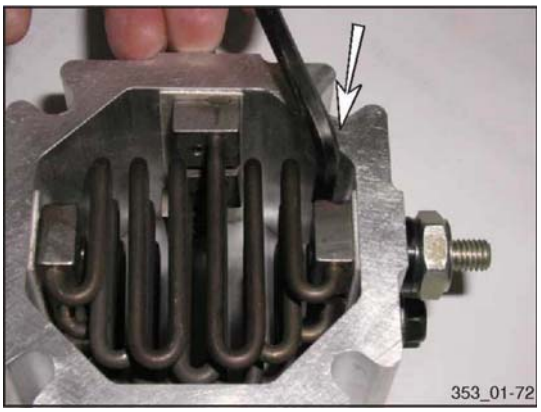


MOUNTING

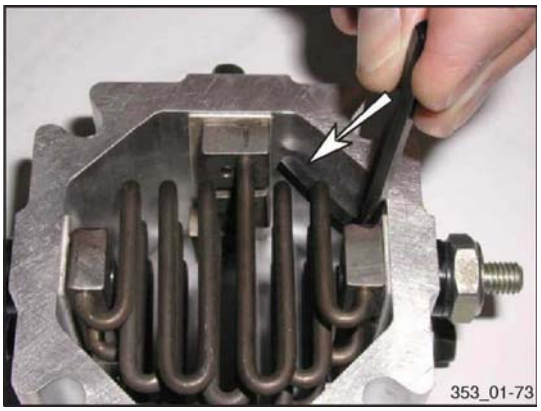
Prior to mounting the special screw TN 0425 8628, the heater flange must be removed from the engine, so that countersupporting with a hollow hexagon wrench is possible during the mounting of the special screw.

The hollow hexagon wrench (size 5) for counter support must be inserted into the heater flange as shown on the photograph.

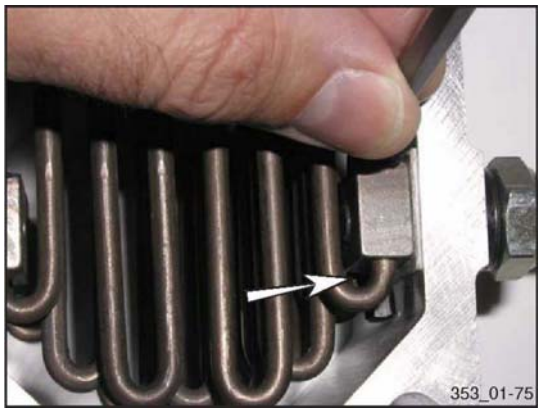




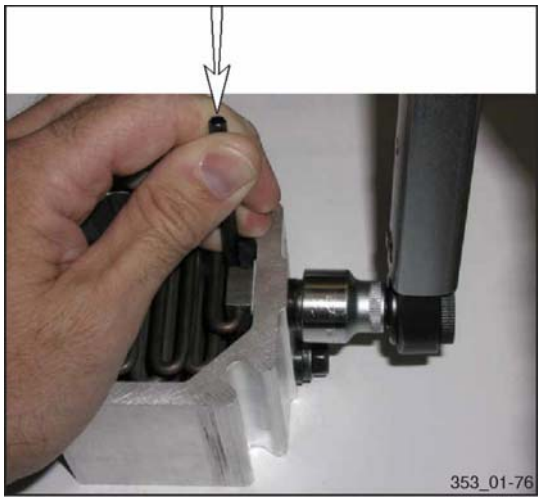
The hollow hexagon wrench must be swivelled in anticlockwise direction.



The hollow hexagon wrench must be swivelled between the upper and the lower heating coil base to be able to counter-support.

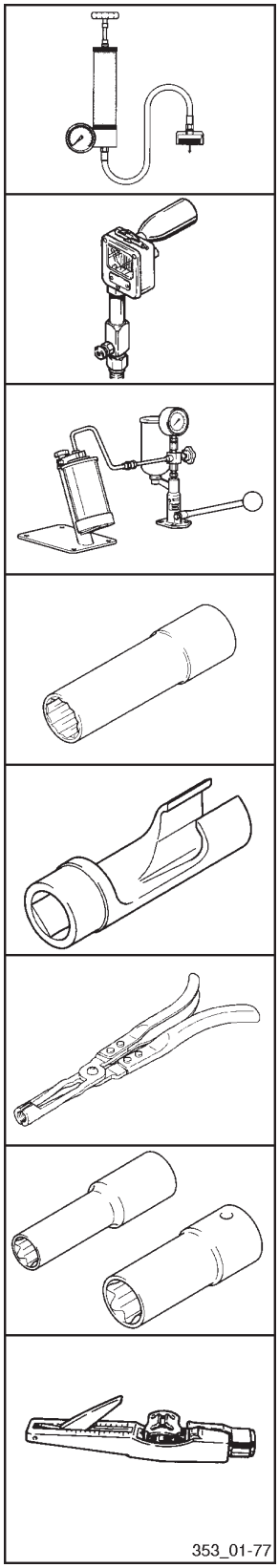


When tightening the special screw, always counter-support with the hollow hexagon wrench (in direction of the arrow), in order to avoid bending of the heating coil. Tightening torque for special screw: 38 Nm.

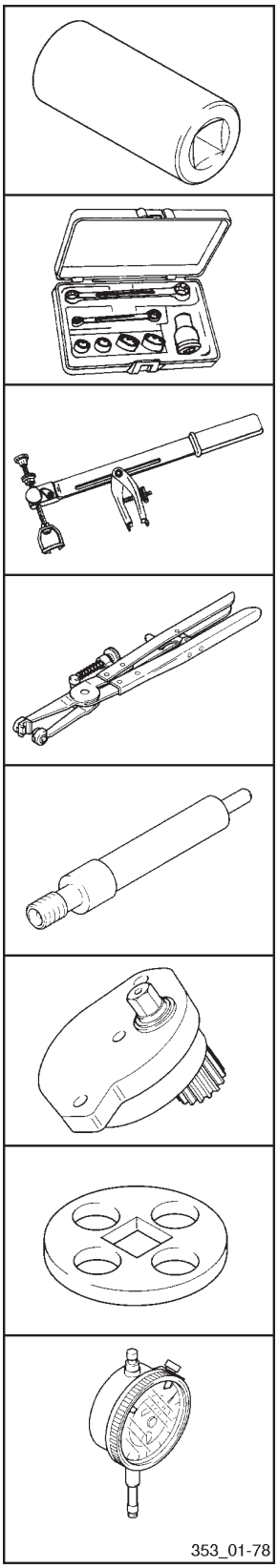


4.1.2.11 SPECIAL TOOLS

No.	Designation
8002	Hydraulic pressure pump for cooler leak test
8005	Compression tester (by IVEKA Automotive Technologies Schanz GmbH, Talweg 8, D-75417 Mühlacker-Lomersheim)
8008	Nozzle tester
8012	Socket SW 15, long design for injection valve (union nut)
8018	Clay-grip wrench a/flats 17 for injection lines
8024	Valve sealing pliers
8113	Torx wrench sockets E14
8114	Torx wrench sockets E20, long version
8115	V-belt tension gauge



8117	Serrated wrench for tuming injection pump
8189	Torx tool kit
9017	Valve spring assembly lever
9090	Spring clamp pliers
100 110	Connector tor compression tester (by IVEKA Automotive Technologies Schanz GmbH, Talweg 8, D-75417 Mühlacker-Lomersheim)
100 320	Turning gear
100 330	Turning gear
100 400	Dial gauge M2T with locking ring



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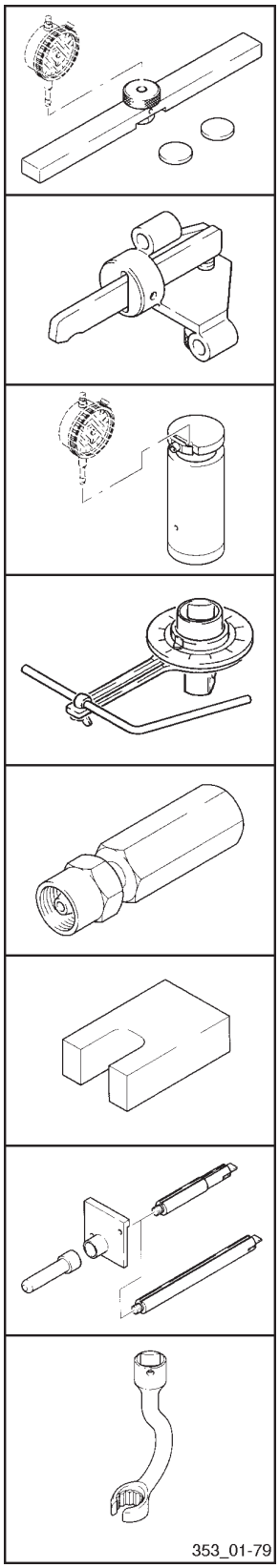
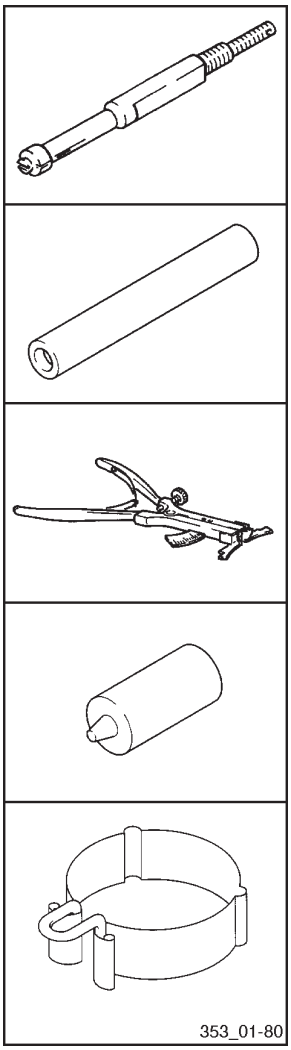
100 750	Measuring bar with spacers tor gauging TDC and piston projection
100 830	Press-on device tor control rod
100 890	Measuring device for base circle measurement
101 910	Tightening angle dial indicator tor main bearing, big-end and flywheel bolts, etc.
110 030	Extractor for injectors, to be used with tool 150 800
110 110	Dolly for injector a/flats 11
110 470	Assembly tool tor control rod sleeves
110 500	Special wrench for injection line



120 680	Extractor for sealing ring beneath injector
121 410	Sleeve for fitting valve stem seal
130 300	Piston ring pliers
130 440	Trapezoidal groove wear gauge
130 660	Piston ring compressor Ø 98 mm



Address your order for special tools to:
Fa. Wilbär, P.O. Box 14 05 80, D-42826 Remscheid

4.2 TRANSMISSION

4.2.1 HYDROSTATIC TRANSMISSION

The transmission is composed of separate components consisting of a high pressure axial variable-displacement pump with integrated control elements and 2 high pressure axial variable-displacement motors. Each hydraulic motor is bolted to a 2-stage planetary hub reduction gear via an intermediate housing that contains the disc brake so forming a compact drive unit for each traction wheel.

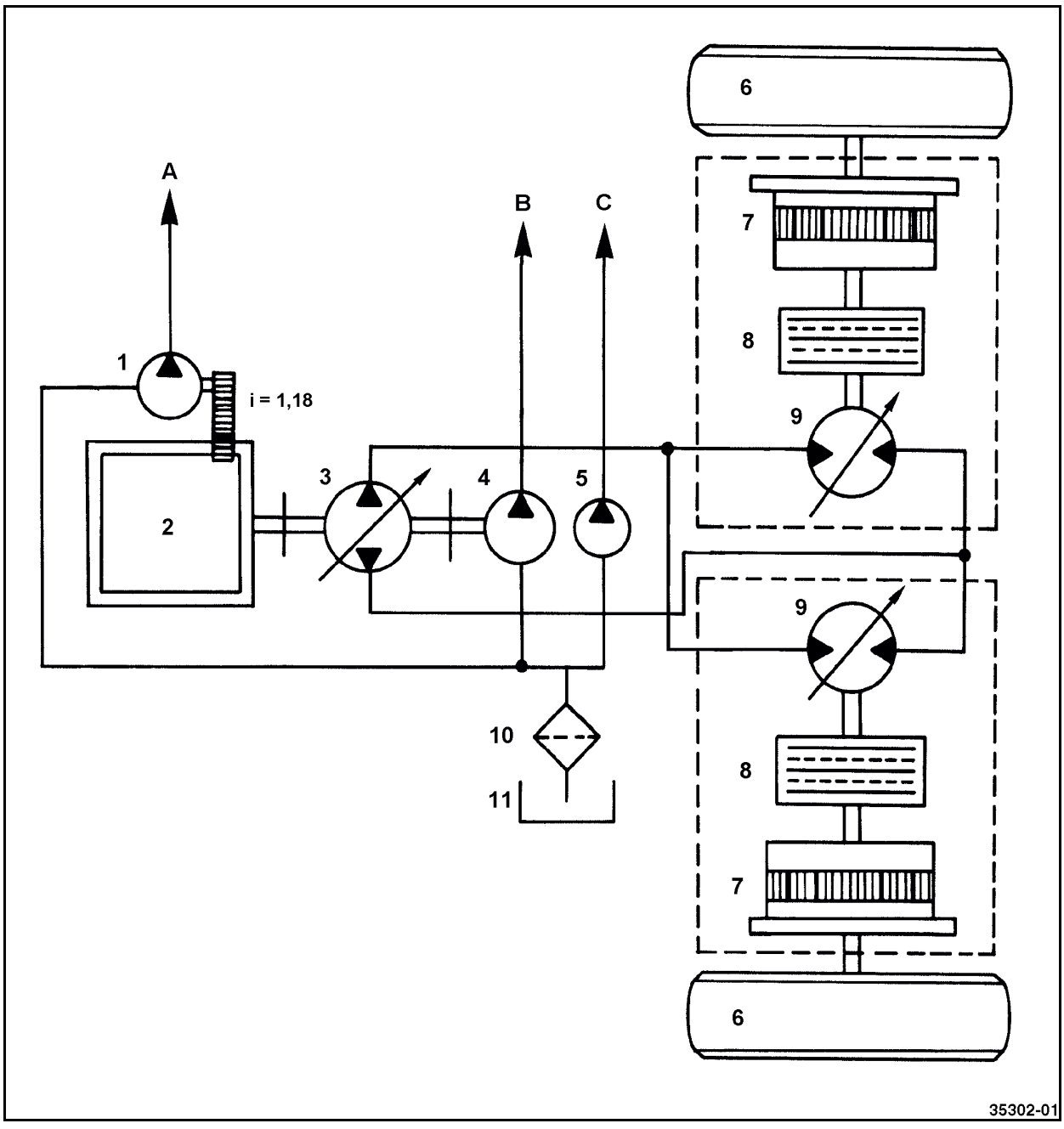
A flange-mounted tandem pump is connected to the shaft of the variable-displacement pump. The first pump supplies boost pressure for the working hydraulics while the second one delivers the pressure for the power steering system. A gear pump serving as delivery pump is driven via an auxiliary power take-off on the engine.

With the proven double-pedal control, a travel control unit is used to select the travel directions, the control pressures for regulating the variable-displacement pump (primary control) and the variable-displacement motors (secondary control) as well as for adjusting the speed of the engine. The disc brakes can be operated even when the engine is running by depressing the brake pedal located between the accelerator pedals.

A speed limiter prevents any overloading of the engine by the transmission. An engine stall during additional loads by the working and steering hydraulics is prevented by the anti-stall device.

When reversing the direction of travel, a lock-out logic ensures that the engine speed does not rise until the truck starts moving in the new direction.

4.2.1.1 SCHEMATIC DIAGRAM OF THE DRIVE



1 Gear pump, 23 cc, due to transmission ration 1 engine revolution = 27 cc
2 Engine KHD BFM 6 1012 E
3 Axial piston pump BPV 100 S
4 Axial piston pump MPF 55 S
5 Gear pump, 27 cc
6 Traction wheels
7 Planetary hub reduction gearbox i = 17.45
8 Disc brake
9 Axial piston motor HMV 105 S
10 Suction filter
11 Oil tank

A Feed
B Working hydraulics
C Steering hydraulics

4.2.1.2 TRANSMISSION SPECIFICATIONS

VARIABLE DISPLACEMENT PUMP

Type:	BPV 100 S
Definition of type designation:	B = Series P = Pump V = Variable-displacement 100 = Max. delivery in cc/rev. S = Swashplate
Number of pistons:	9
Piston diameter:	22.5 mm
Max. swashplate angle:	18 °
Max. operating pressure:	330 bar, H 50/60 390 bar, H 70/80
Boost/control pressure:	17.5 bar
Max. speed:	2250 RPM
Q_{max} at n_{max}:	225 l/min
Q_{max} of feed pump:	60 l/min
Type of control:	hydraulic
Operation:	hydraulic remote control
Start/end of control:	4 - 10 bar
Overload protection:	hydraulic power control, load-sensing
Pump drive:	Curved teeth coupling

TANDEM PUMP

1 pump for working hydraulics

Type:	MPF 55 S
Definition of type designation:	M = Medium pressure P = Pump F = Fixed displacement 55 = Delivery 55 cc/rev. S = Swashplate
1 gear pump for steering:	27 cc/rev.

WHEEL DRIVES

Two wheel drives bolted to frame

Each unit consists of:

1 variable-displacement hydraulic motor HMV 105 S

Definition of type designation:	H = High pressure M = Motor V = Variable displacement 105 = Max. displacement in cc/rev. S = Swashplate
Number of pistons:	9
Piston diameter:	21 mm
Swashplate angle/displacement:	max. 20.8 °/105 cc min. 8 °/40 cc
Start/end of delivery:	7 bar/10 bar

1 oil-pressure operated disc brake

- mounted on extended engine shaft
- fully encapsulated, running in oil
- required only as parking brake and emergency brake

1 planetary hub reduction gearbox i = 17.45

4.2.1.3 HYDRAULIC CIRCUIT DIAGRAM

A WORKING HYDRAULICS

1 Control valve block consisting of:
2 Way valve (auxiliary hydraulics)
3 Shuttle valve
4 Way valve (auxiliary hydraulics)
5 Pressure holding valve
6 Way valve - tilting
7 Way valve - lifting
8 Pressure reducing valve
8a Restrictor
8b Restrictor
9 2/2-way valve (pressure balance)
10 Maximum pressure valve, 265 bar
11 Tilt cylinder
12 Slow down valve
13 Lift cylinder

B STEERING CONTROL VALVE ASSEMBLY

14 Pressure relief valve
15 Make-up valve
16 Shock valve
17 Steering control valve

C STEERING CYLINDER

D SHUTTLE VALVE

E OIL COOLER

F COOLER BYPASS VALVE, 1 bar

G BOOST PRESSURE PUMP

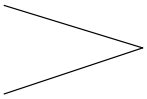
18 Gear pump, 23 cc/rev.; i = 1.18, resulting in 27 cc/rev.
18a Way valve - auxiliary braking
18b Restrictor
18c Restrictor

H ENGINE

J ENGINE SPEED CONTROL CYLINDER

K VARIABLE-DISPLACEMENT PUMP BPV 100, ASSY.

19 Variable-displacement pump
20 3/2-way valve
21 3/3-way valve



Reversing lock

22 Control piston
22a Nozzles, 1.44 mm
23 4/3-way valve - pilot valve
24 Servo piston
25 Combined feed and pressure-relief valve 330 $^{+20}$ bar (H 50/60)/390 $^{+20}$ bar (H 70/80)
26 Boost pressure valve 17.5 bar

L WORKING HYDRAULICS PUMP

27 Axial piston pump MPF 55

M POWER STEERING PUMP

28 Gear pump 27 cc/rev

N POWER LIMITER

29 6/2-way valve
30 Pressure reducing valve

31 High-pressure modulator
32 Nozzles
33 Pressure-relief valve
40 3/2-way valve
41 Nozzle
42 By-pass valve

O PRESSURE FILTER 10 microns

P TRAVEL CONTROL UNIT ASSEMBLY

43 Pressure reducing valve
44 Pressure-relief valve
45 Restrictor
46 4/2-way valve - brake actuation
47 2/2-way valve
48 4/3-way valve - direction of travel
49 3/2-way valve - signal for engine speed

Q HYDRAULIC DRIVE UNIT ASSEMBLY

50 Pressure-relief valve
50a Restrictor
51 3/3-way valve
52 Hydraulic motors
53 4/2-way valve - pilot valve
53a Restrictor
53b Restrictor
54 Disc brakes
55 Control piston

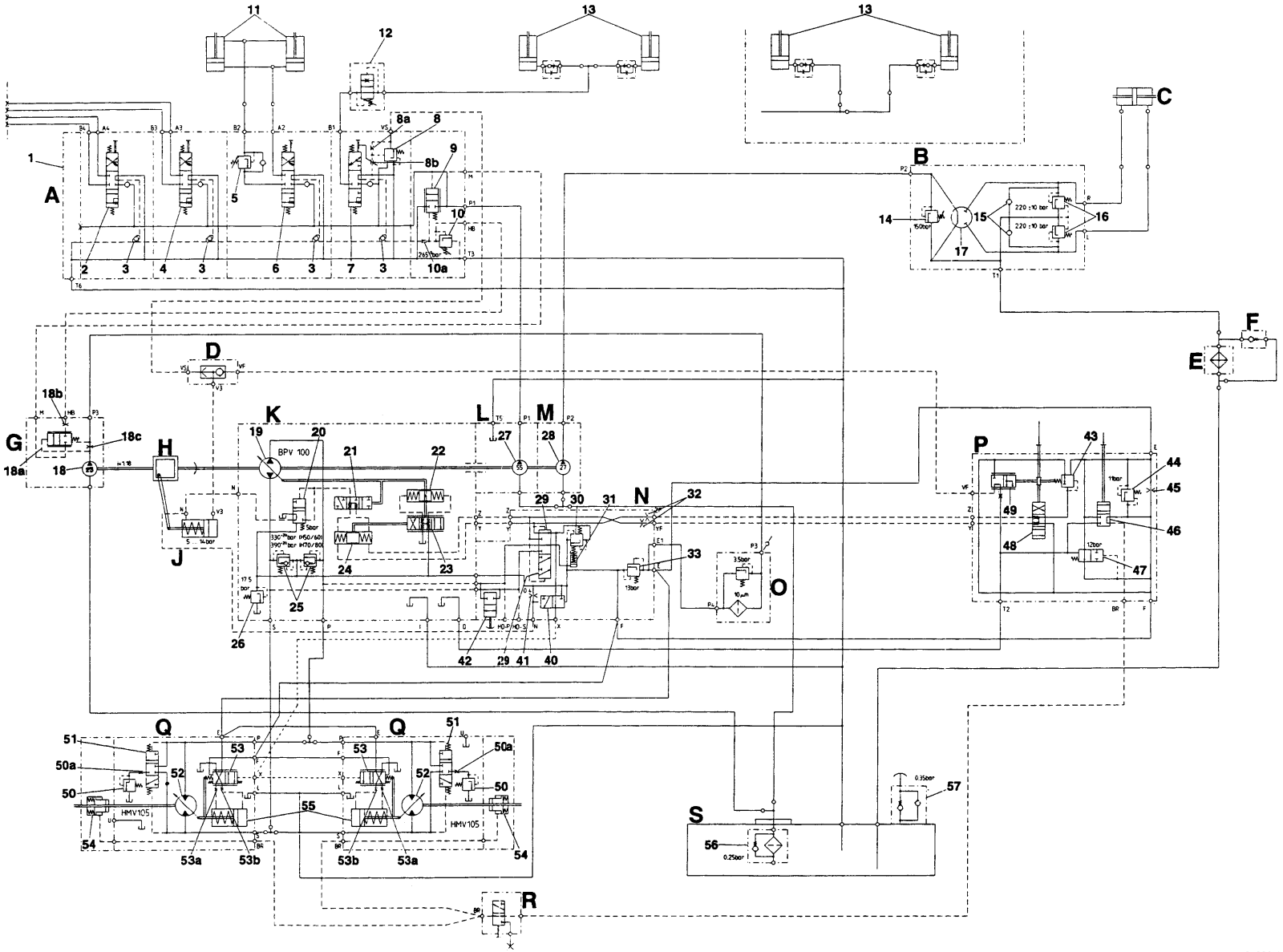
R 3/2-WAY VALVE - EXTERNAL BRAKE RELEASE

S OIL TANK

56 Suction filter
57 Suction and pressurizing valve with filter $0.35\ ^{+0.15}$ bar

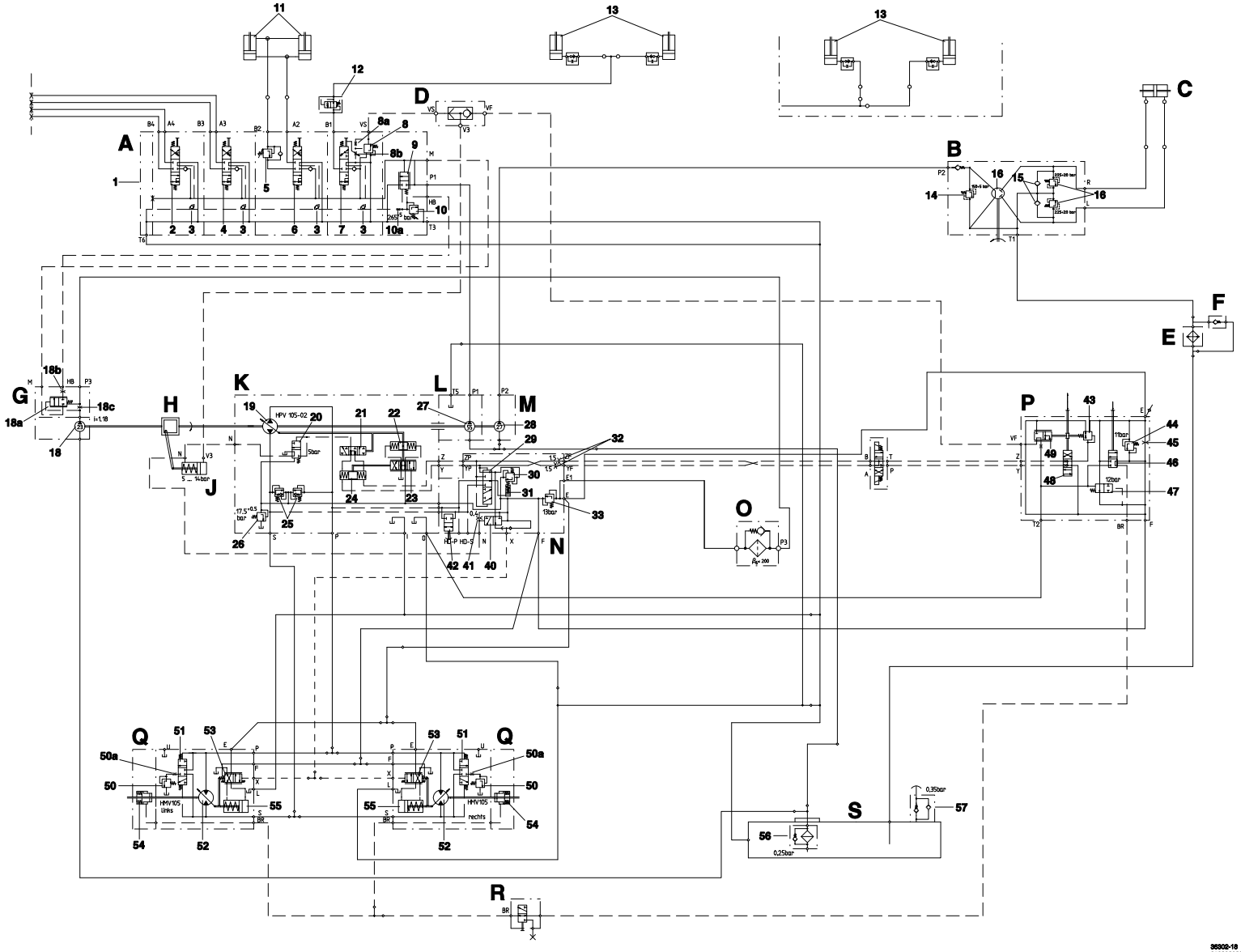
Service Training

HYDRAULIKSCHALTPLAN H 50/60/70/80, TYP 353

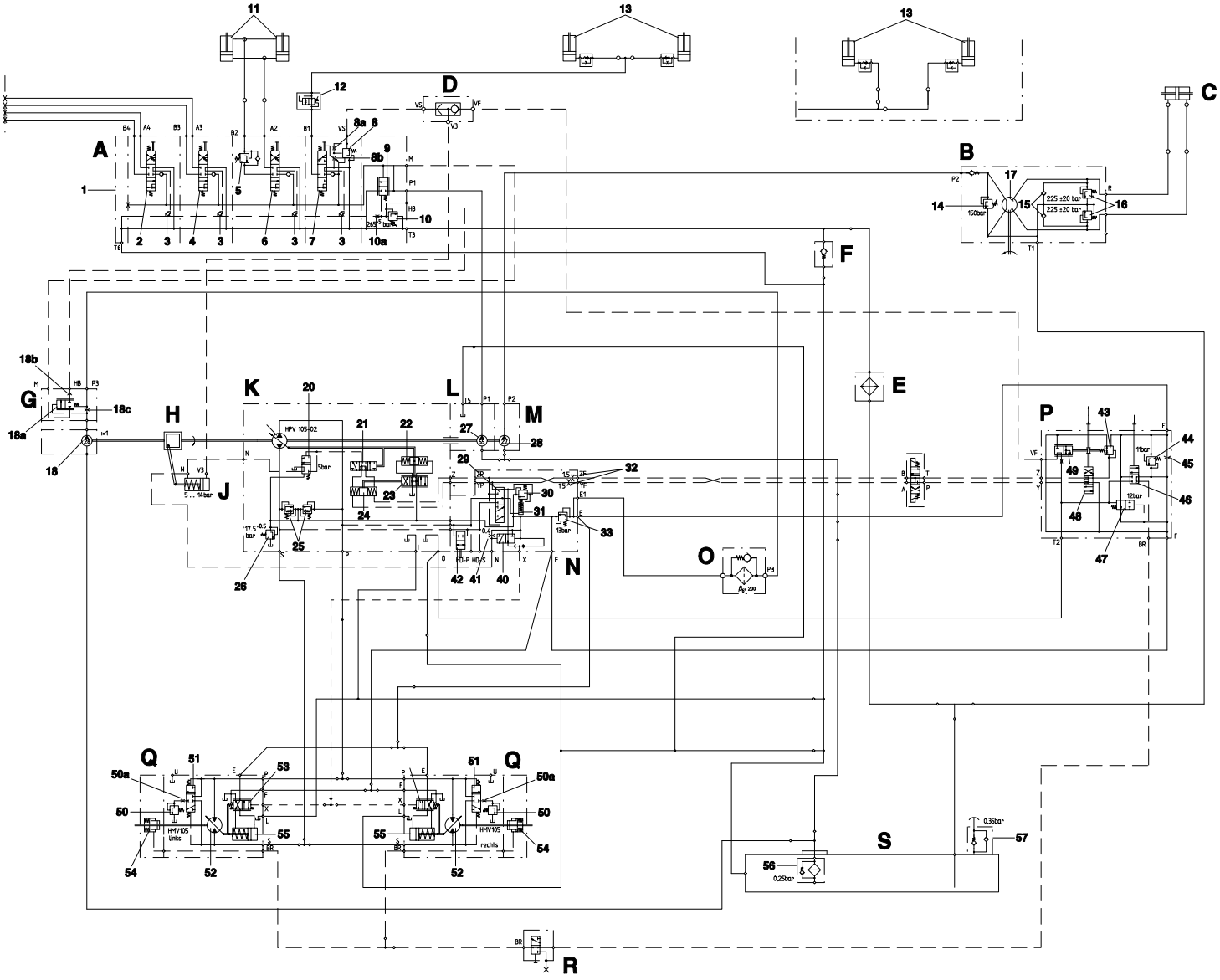


Service Training

HYDRAULIKSCHALTPLAN H 50/60/70/80 D-02, BAUREIHE 353



HYDRAULIKSCHALTPLAN H 50/60/70/80 T-02, BAUREIHE 353



HYDRAULIC CIRCUIT DIAGRAM, TYPE 353 -03

A WORKING HYDRAULICS

1 Control valve block consisting of:
2 Way valve (auxiliary hydraulics)
3 Way valve (auxiliary hydraulics)
4 Way valve (tilting)
5 Way valve (lifting)
6 Restrictor
7 Pressure reducing valve
8 2/2-way valve (pressure balance)
9 Maximum pressure valve, 265 $^{+5}$ bar
10 Shuttle valve
11 Pressure holding valve
12 Tilt cylinder
13 Slow down valve
14 Lift cylinder H 50/H 60
15 Line breakage protection
16 Lift cylinder H 70/H 80

C STEERING CONTROL VALVE ASSEMBLY

17 Pressure relief valve
18 Make-up valve
19 Shock valve
20 Steering control valve

D STEERING CYLINDER

E BOOST PRESSURE PUMP

21 Restrictor
22 Gear pump, 23 cc/rev.
23 Way valve - auxiliary braking

F ENGINE

G ENGINE SPEED CONTROL CYLINDER

H VARIABLE-DISPLACEMENT PUMP HPV 105-02, ASSY.

24 Variable-displacement pump
25 3/2-way valve
26 3/3-way valve
Reversing lock
27 Control piston
28 4/3-way valve - pilot valve
29 Servo piston
30 Combined feed and pressure-relief valve
- pressure-relief valve 285 $^{+15}$ bar (H50)
- pressure-relief valve 305 $^{+15}$ bar (H60)
- pressure-relief valve 360 $^{+15}$ bar (H70/80)
- pressure-relief valve 420 $^{+15}$ bar (H80/900)
31 Boost pressure valve 17.5 bar

J WORKING HYDRAULICS PUMP

32 Axial piston pump MPF 55

K POWER STEERING PUMP

33 Gear pump 27 cc/rev

L POWER LIMITER

34 6/2-way valve
35 Nozzles
36 Pressure reducing valve

37 Pressure-relief valve 13 bar
38 High-pressure modulator
39 3/2-way valve
40 By-pass valve

M TRAVEL CONTROL UNIT ASSEMBLY

41 3/2-way valve - signal for engine speed
42 Pressure reducing valve
43 Pressure-relief valve 11 bar
44 Restrictor
45 4/2-way valve - brake actuation
46 2/2-way valve 12 bar
47 4/3-way valve - direction of travel
48 Way valve - direction of travel (single pedal) (optional equipment)

N OIL COOLER

O OIL FILTER

49 Filling device

P HYDRAULIC DRIVE UNIT ASSEMBLY

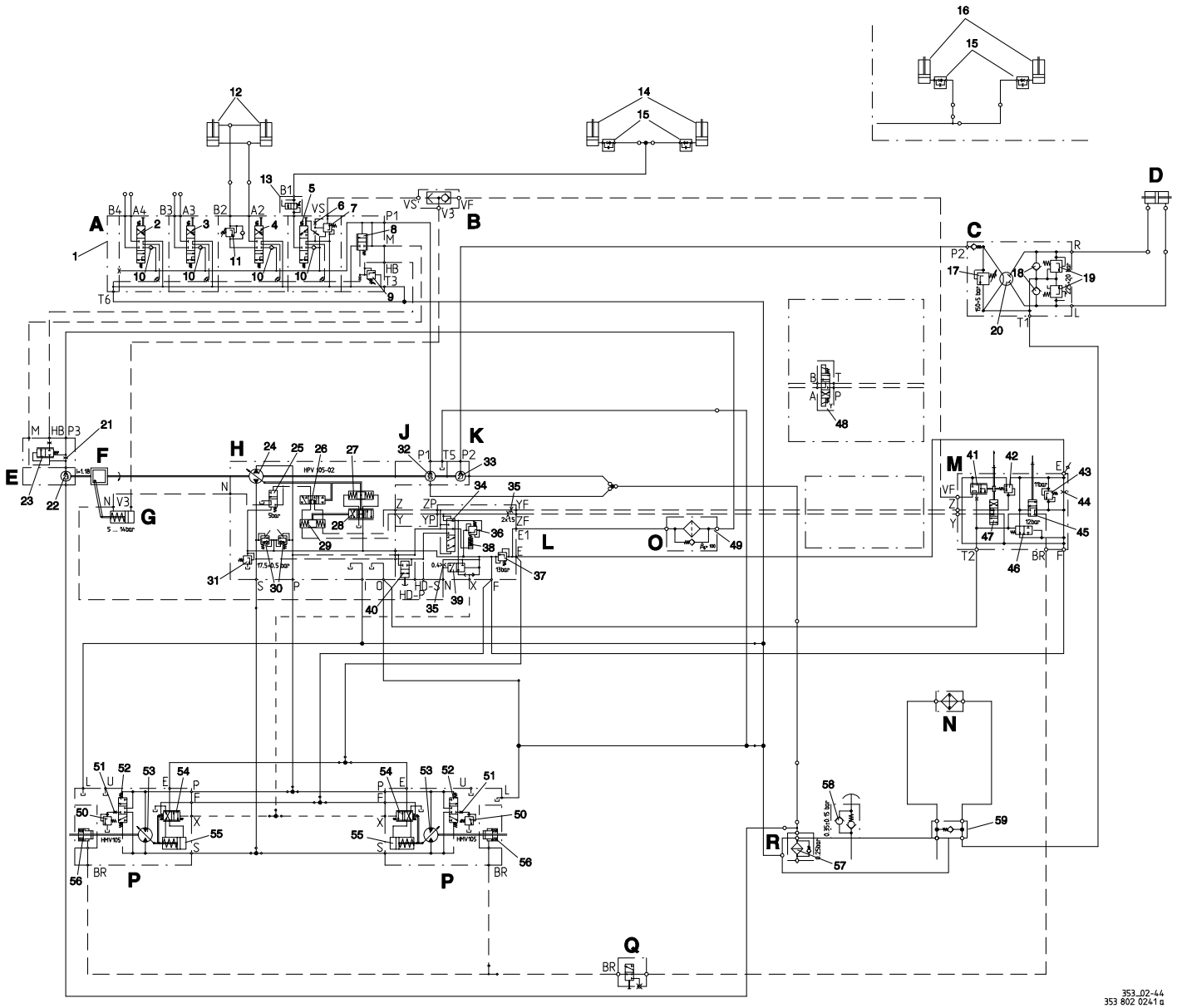
50 Pressure-relief valve
51 Restrictor
52 3/3-way valve
53 Hydraulic motor HMV 105
54 4/2-way valve - pilot valve
55 Control piston
56 Disc brakes

Q 3/2-WAY VALVE - EXTERNAL BRAKE RELEASE

R OIL TANK

57 Suction filter 0,25 bar
58 Suction and pressurizing valve with air breather filter 0.35 bar
59 Distributor kit

HYDRAULIC CIRCUIT DIAGRAMM H 50/60/70/80 D-03, TYPE 353



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4.2.2 OPERATION OF THE HYDROSTATIC TRANSMISSION

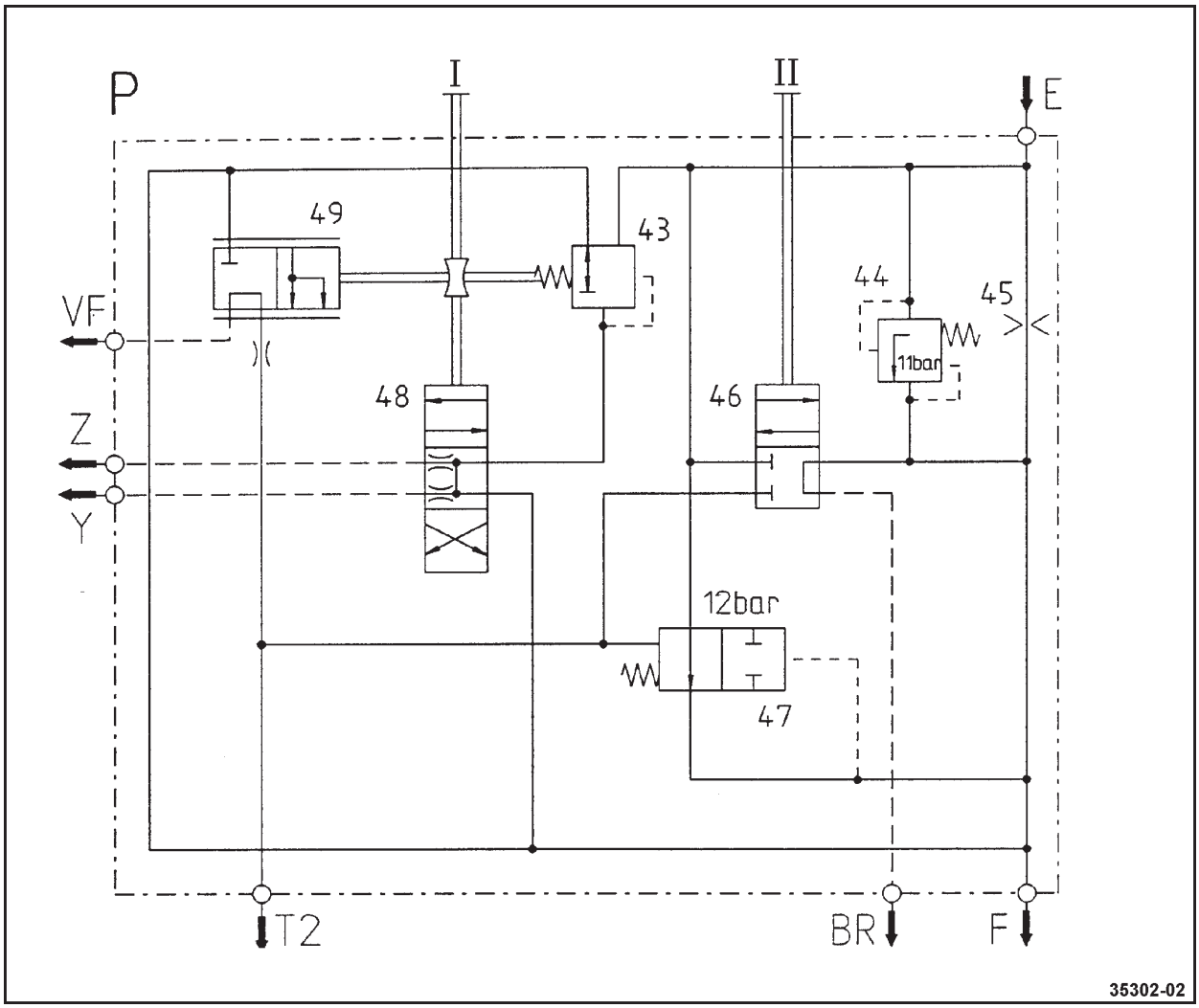
The oil flow (20 L/min at n_{min}1, 60 L/min at n_{max}) generated by boost pressure pump G goes through filter O to control valve block N entering it at port E1 and leaving at port E, from where it goes to port E of the travel control unit P.
The oil flows through the restrictor (45) and leaves the travel control unit at port F to enter control valve block N at port F, and then the feed valves (25) and the boost pressure valve (26), which stabilizes the boost pressure at 17.5 bar.

4.2.2.1 TRAVEL CONTROL UNIT P

The way valve (47) which is pressurized to 12 bar and open at first is arranged in parallel to the restrictor (45). After the boost pressure increases to 17.5 bar at F the valve is pushed to the closed position. The pressure-relief valve (44), which is also arranged in parallel to the restrictor (45), ensures a constant differential pressure of 11 bar between E and F. The feed and control pressure of 17.5 bar goes through the way valve (48), travel direction, and the pressure reducing valve (43) to ports Y and Z and from there to the servo piston (24) to which equal pressure is applied on each end. The pressure of 17.5 bar is applied via way valve (46), the brake valve and port BR to the disc brakes as brake release pressure. This pressure is also applied to the way valve (49), speed control valve as boost pressure for control of the engine. The higher pressure with a differential pressure of 11 bar created by restrictor (45) and valve (44) is applied at the pressure reducing valve (43) as boost pressure.

When an accelerator pedal is depressed, way valve (48) determines the direction of travel while valve (49) and pressure reducing valve (43) establish the pilot pressures controlling engine speed and pump output. When the stroke of the accelerator pedal creates a differential pressure of 4 bar between Y and Z, the pump begins delivery and the truck starts to move. At the same time a pressure of 7 bar goes from valve (49) through port VF to the speed control piston, increasing the engine speed to approx. 1200 rpm (jump in speed). As the accelerator pedal is depressed further, the differential pressure between Y and Z rises to approx. 10 bar, whereas the pressure at VF remains constant. The Q_{max} of the pump (19) and Q_{min} of the hydraulic motors (52) is reached at a differential pressure of 10 bar (primary/secondary control) without increasing the engine speed, however. Depressing the pedal still further modulates valve (49) and increases the pressure in proportion to the pedal stroke to approx. 17.5 bar (end of pedal stroke). The engine is brought to maximum RPM and the truck achieves maximum speed.

Depressing the brake pedal fully when an accelerator pedal is operated opens valve (46) so that the pressure goes from F (feed pressure) to valve (43) as boost pressure. This reduces the differential pressure between E and F; consequently the differential pressure between Y and Z drops to under 4 bar, causing the pump to downstroke to zero output. At the same time port BR is connected via T2 to tank, reducing the brake release pressure and so applying the brakes. A reduction in pressure to under 12 bar at port F (leak in the closed circuit) opens valve (47). As a result restrictor (45) is bypassed and no differential pressure can build between E and F, preventing an upstroking of the pump when the brake is applied.



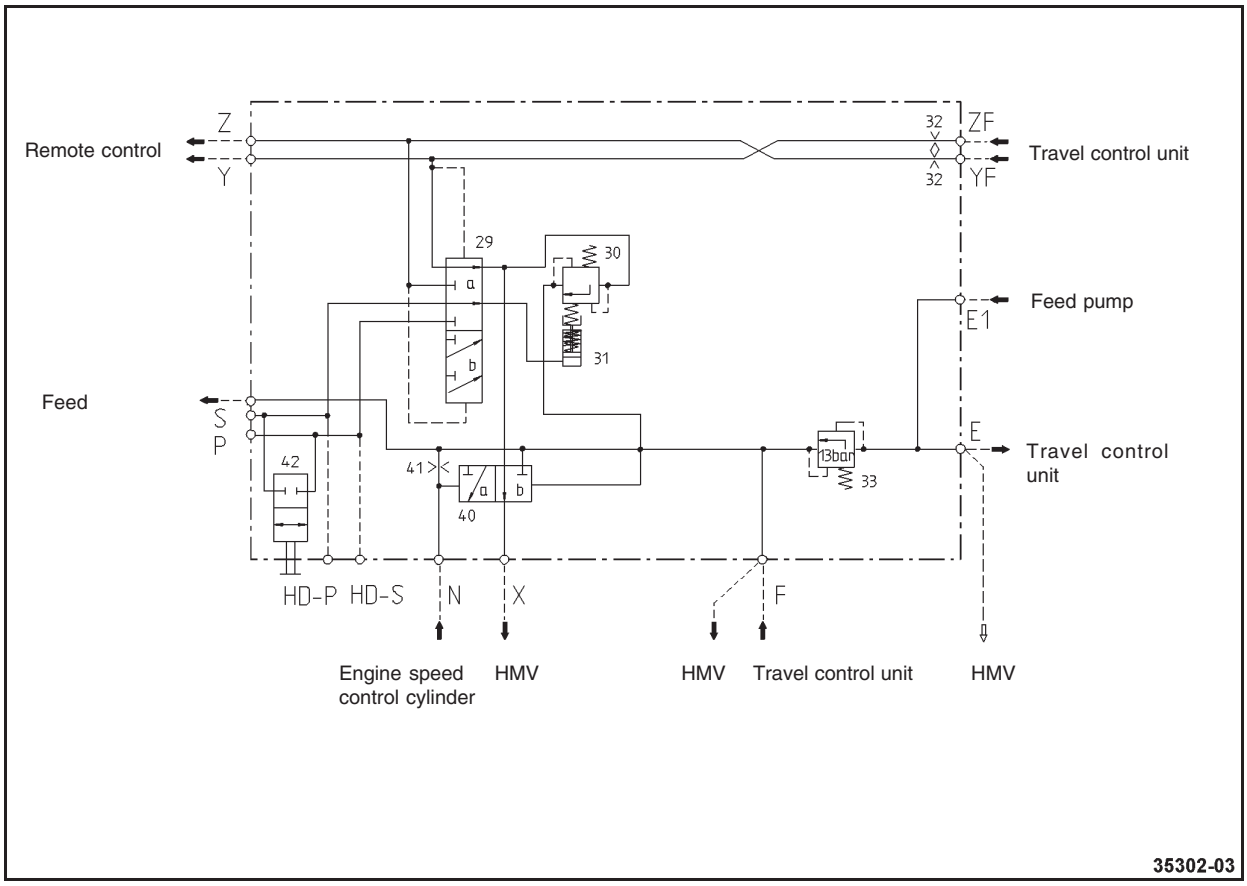
Travel Control Unit

I Operation
Travel direction, swashplate angle, maximum rpm

II Operation
Brake

43 Pressure regulating valve - swashplate angle
44 Pressure-relief valve, 11 bar
45 Restrictor - for differential pressure
46 4/2-way valve - braking
47 2/2-way valve, 12 bar - brake protection
48 4/3-way valve - travel direction
49 3/2-way valve - signal for maximum rpm

4.2.2.2 OPERATION OF CONTROL VALVE BLOCK N = POWER LIMITER



The feed pressure oil flows via E1 and E through control valve block N, goes through travel control unit P from port E to F and returns to the control valve block through port F. The feed pressure valve (26) stabilizes a pressure of 17.5 bar at port F, which is fed to the remote control of the hydraulic motors through an oil line.

Valve (33), which is connected in parallel to ports E and F of the control valve block, opens at a differential pressure of 13 bar. This allows a part of the oil flow to go to the travel control unit while the remainder continues through valve (33) to the feed oil passage. The pressure at port E goes to the HMV hydraulic motors via a line as pilot pressure. The setting of valve (29) is determined by the differential pressure between Y and Z. If, due to the selection of a travel direction, a higher pressure exists at Z, valve (29) is shifted to position (a) and the higher pressure Y goes to the pressure reducing valve (30). At the same time the pressure applied through valve (40), which is switched to position b by the feed pressure, goes to the hydraulic motor remote control through port X.

When the pressure ranges from 4 to 10 bar, the differential pressure between Y and Z modulates the pilot valve (23) with the servo piston (24) and sets the pump from zero delivery to Q_{max} with control piston (22). The same pressure also adjusts the hydraulic motors from Q_{max} to Q_{min} when the pressure ranges from 7 to 10 bar.

POWER LIMITER, ANTI-STALL DEVICE

The drive is provided with a power limiter to prevent any overload on the engine by the travel drive.

This device controls the swashplate angle of the variable-displacement pump and the variable-displacement motors depending on the high pressure so that the product of flow volume Q x working pressure P does not exceed the available engine power at any time.

EXPLANATION

When an accelerator pedal is depressed, the higher pilot pressure at Z or Y goes via the activated preselector valve (29) to pressure reducing valve (30), while the working pressure of the closed circuit goes through valve (29) to the high-pressure modulator (31). After the selected engine power is achieved (Q_{max} and approx. 170 bar), valve (30) is activated via the high-pressure modulator (31), thus reducing the differential pressure between Y and Z. This causes the pump to downstroke from Q_{max} towards Q_{min}, thus reducing the oil flow. At the same time the hydraulic motors stroke up from Q_{min} to Q_{max}, increasing the torque at the traction wheels.

Any additional power requirements by the working and steering hydraulics cannot be served by the power limiter. This overloads the engine and, if the power requirement continues, reduces its speed. If the engine speed drops until the differential pressure between Y and Z is reduced to 4 bar, the pump will downstroke to zero delivery, thus preventing the engine from stalling.

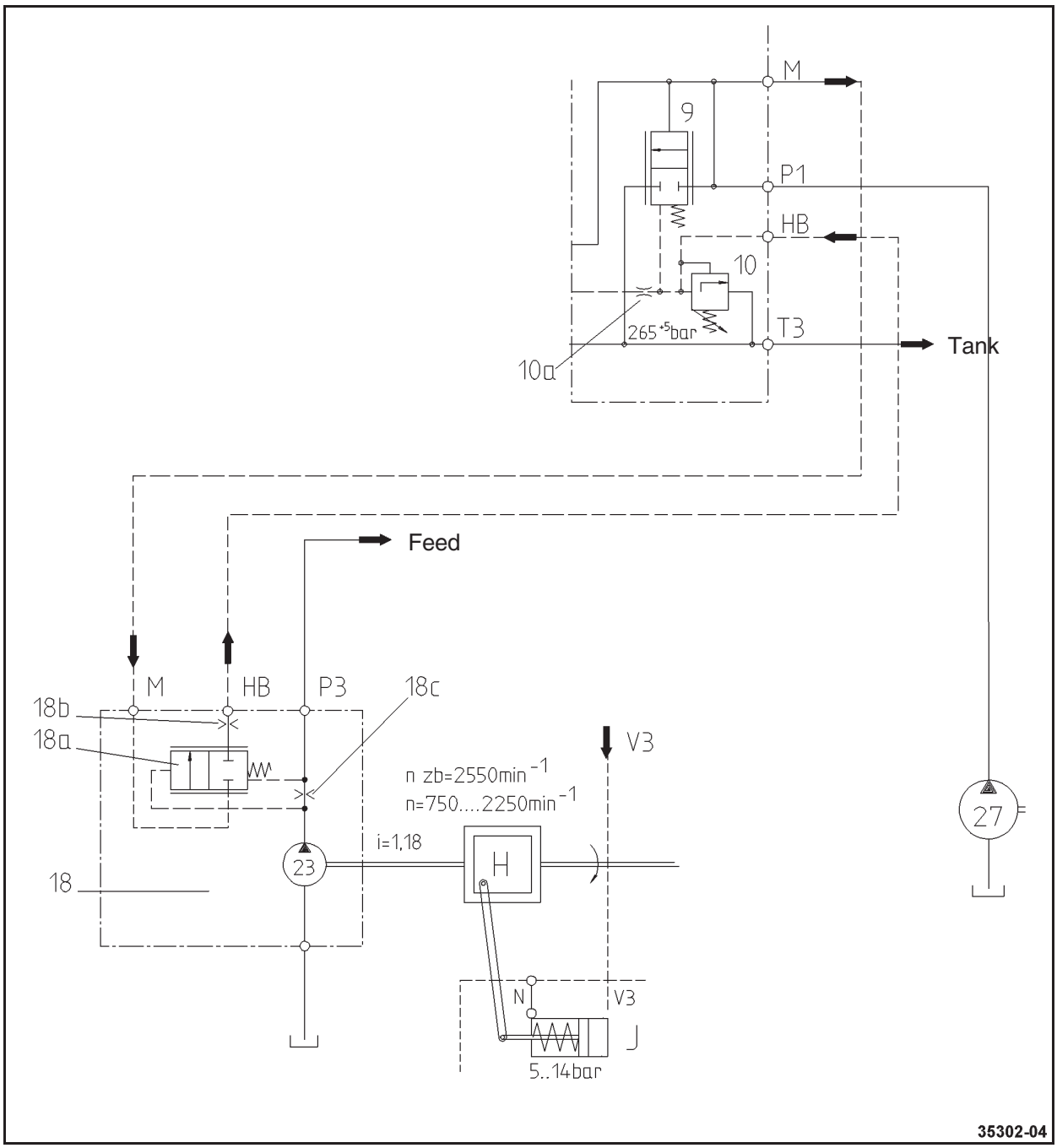
4.2.2.3 BRAKING

When the accelerator pedal is released, the pressure for the engine speed control cylinder is first reduced and then the differential pressure between Y and Z so that the hydraulic motors stroke from Q_{min} to Q_{max} and the pump from Q_{max} to zero output. This reduces truck speed, braking the truck.

4.2.2.4 AUXILIARY BRAKE

Due to the reversal of power when braking (tractive power converted to pushing power), the hydraulic motors drive the pump, which is coupled to the engine, so that the engine speed must rise as a result. When a determined engine speed is reached, the auxiliary brake is applied, preventing the engine speed from rising too high. The maximum braking force is determined by the pressure-relief valve in the high-pressure circuit.

EXPLANATION

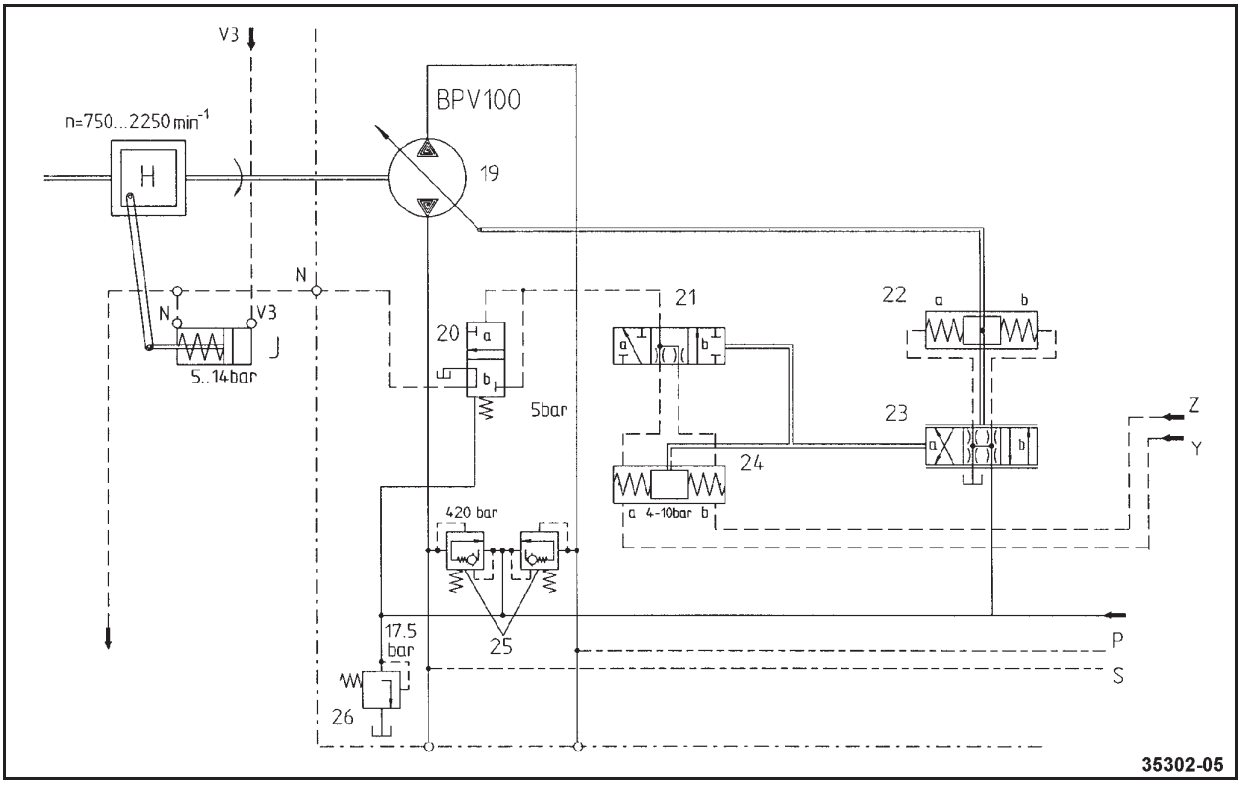


The oil flow from the feed pump (18) goes through restrictor (18c) and is fed through port P3 into the oil circuit. Way valve (18a) is kept closed by a spring. Restrictor (18c) is used to measure a differential pressure whose size is proportional to the flow, i.e. it varies with engine speed. The nearly constant pressure upstream of the restrictor goes into the spring chamber of valve (18a), whereas the speed-dependent pressure is applied against the spring pressure. When the engine speed reaches approx. 2250 rpm, valve (18a) opens and sends the working pressure applied at port M through 18 b to port HB

at the pressure balance in the working hydraulics way valve block. This causes the pressure balance to close, thus increasing the pressure of the oil flow of the working hydraulic pump (27). The power required from the engine prevents the rpm from rising too high during braking.

4.2.2.5 LOCK-OUT LOGIC - REVERSING LOCK

When the direction of travel is reversed quickly, the differential pressure changes from Y/Z to Z/Y faster than the pump can follow. At the same time the speed signal is set by travel control unit P through port VF to speed control cylinder J for maximum engine speed. Simultaneously, the signal for Q_{min} is applied to port X of the hydraulic motors.
d
As the inertia of the truck drives the engine via the hydraulic motors and pump and lets the engine overspeed during braking, the braking distance would be very long. The specified braking delay is achieved through the auxiliary braking and during reversing the reversing lock also becomes effective.

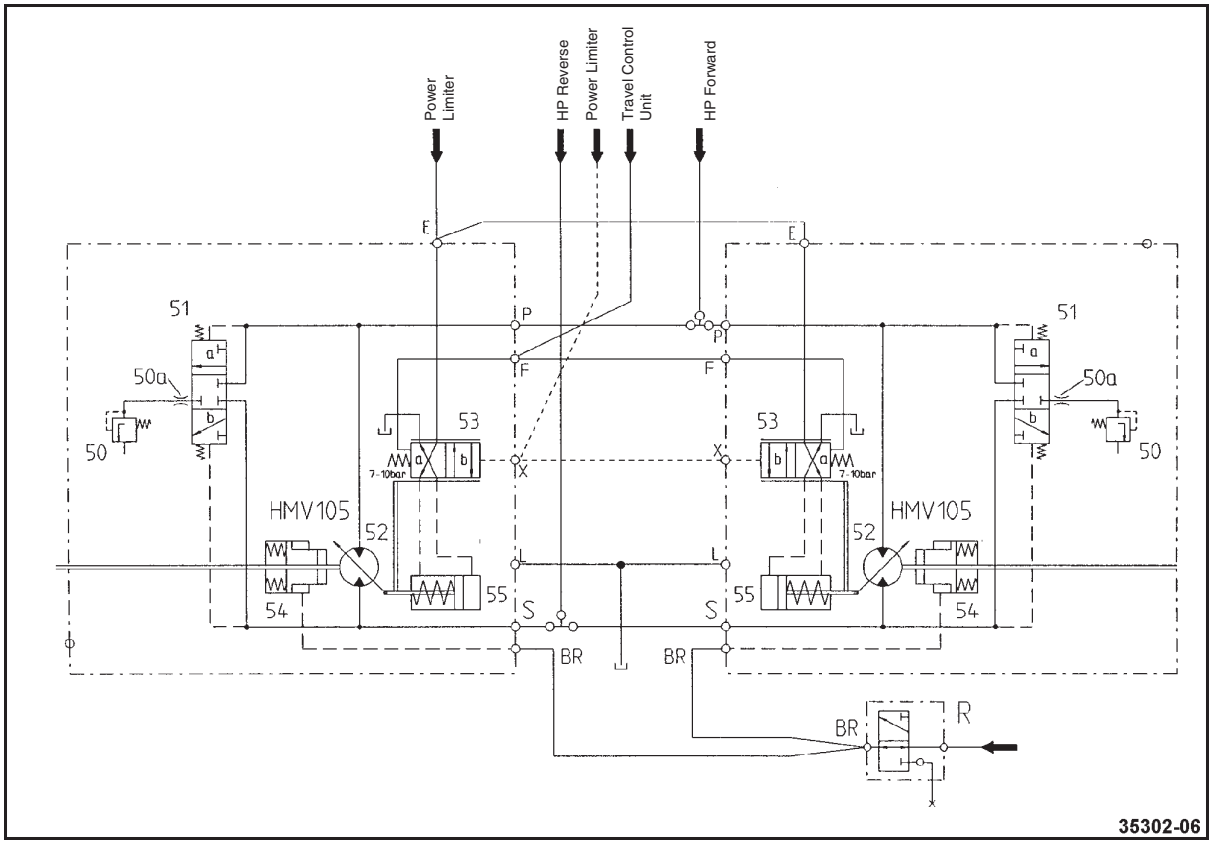


EXPLANATION

When the pilot pressure for pump and engine control is preselected at Y by depressing the related accelerator pedal, it goes to spring chamber (a) in the servo piston (24), while the constant feed pressure is applied in spring chamber (b). This causes the spool to move to (b), shifting the pilot valve to position (a) by means of the mechanical connection. This allows the constant pressure of 17.5 bar to go into spring chamber (a) of the control piston (22) through valve (23). The piston shifts to (b), causing the pump to upstroke and valve (21) to move to position (a). The pressure of 17.5 bar existing in spring chamber (b)

at piston (24) continues through open valve (21) to valve (20), which is shifted to position (b) by the 5 bar spring and the feed pressure in the spring chamber. This connects the spring chamber of control cylinder J via port N to the tank.

When the travel direction is reversed quickly, the pressure in spring chamber (a) of the servo piston (24) drops to 17.5 bar, whereas in spring chamber (b) the pilot pressure will rise to a differential pressure of approx. 10 bar. As the servo piston can only follow the change in pressure with a delay, valves (23) and (21) and piston (22) are still in their original position. This causes the higher pressure in spring chamber (b) of servo piston (24) to go through valve (21) to valve (20), shifting it to position (a). The pressure now goes through the shifted valve to port N (spring chamber) of engine speed control cylinder J, pushing it against the speed signal applied at port V3 so that the injection pump is set to lower idling speed.



This pressure is also sent to port N at control valve block N, shifting valve (40) to position (a). The 17.5 bar pressure from the feed oil passage now goes through the open valve via port X to the remote control for the hydraulic motors. Via ports F, the same pressure exists in the spring chamber of the control pilots as at port X. Due to the pressure bias, the pilot is shifted so that the pressure applied at E goes to the rod end of the control piston (55), while the piston end is connected to the tank. The shift of the piston cause the motor to be regulated to Q_{max}, thus increasing the braking force.

4.2.2.6 FLUSHING OF THE CIRCUIT AND HOUSING

In order to prevent extremely high oil temperatures in the closed circuit, the drive is provided with circuit flushing through an output control device. The temperature in the hydraulic units and the tank is also approximated by flushing the pump and the motor housing.

CIRCUIT FLUSHING

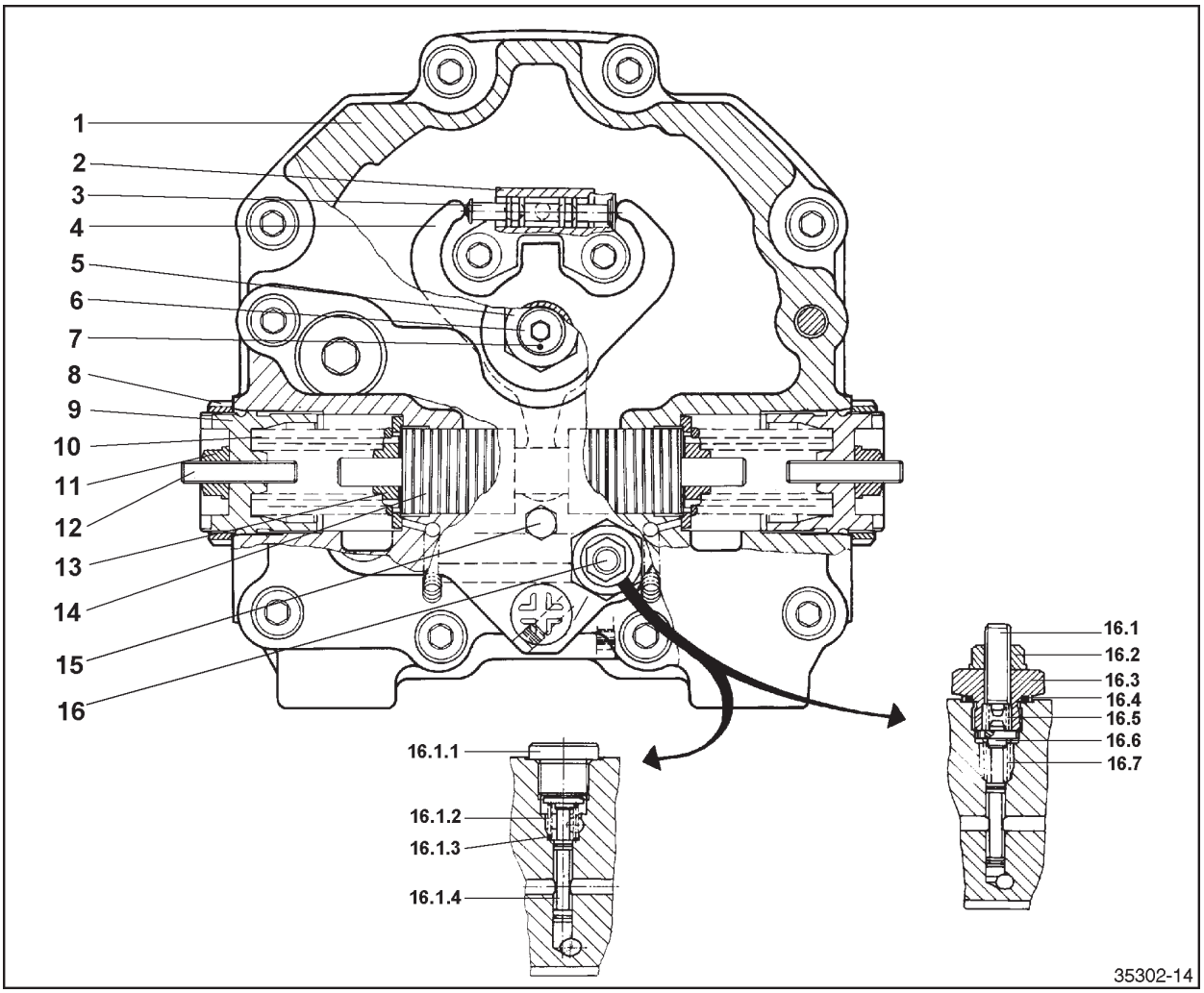
Each hydraulic motor has an output control device consisting of valve (50), nozzle (50a) and valve (51). If high pressure exists at P, valve (51) shifts to position (a). The low pressure at S goes through the open valve (51) and the nozzle (50a) to the pressure-relief valve (50) set to 13 bar and to the opening valve into the motor housing. A differential pressure of 7.5 bar exists between valve (50) and low pressure. Due the size of the nozzle (50a), the quantity of oil emitted is fixed to 3 litres per hydraulic motor. The quantity of oil leaving at the low pressure side is replaced by cool oil flowing in through the feed valves. This method, together with the leakage caused by the high pressure, allows the entire circulating oil to be replaced several times per minute.

HOUSING FLUSHING

The cool oil delivered by pump G goes through filter O and travel control unit P to the feed valves (25). The appropriate feed valve returns the same quantity of oil into the circuit as is lost due to leakage and removed as output oil. The remaining quantity is blown off through the feed pressure valve (26) into the pump housing, from where it flows back to the tank via port I.

The oil quantity removed from the closed circuit through the output device goes into the related motor housing and from there to the tank, together with the leakage oil.

4.2.3 HYDRAULIC REMOTE CONTROL



1	Cover	16	Reversal lock
2	Pilot housing		
3	Control pilot	up to 4/94: 16.1	Setscrew
4	Control lever	16.2	Sealing nut
5	Hexagonal nut	16.3	Screw
6	Eccentric pin	16.4	O-ring
7	Position mark	16.5	Adjustment spring
8	Grooved nut	16.6	Valve piston
9	Setscrew	16.7	Valve spring
10	Springs		
11	Nut	from 5/94: 16.1.1	Screw
12	Threaded pin	16.1.2	Valve spring
13	Spring plate	16.1.3	Shims
14	Servo piston	16.1.4	O-ring
15	Bleed screw	16.5	Valve piston

4.2.3.1 ADJUSTMENTS

CONDITIONS

- Jack up and securely block the truck so that both traction wheels can rotate freely.
- Hydraulic oil at operating temperature.

4.2.3.1.1 HYDRAULIC NEUTRAL POSITION

- Hold the eccentric pin (6) with a socket head spanner.
- Slacken the hexagonal nut (5).
- Start the engine and let it idle.
- Gently turn the eccentric pin (6) with the socket head spanner until the traction wheels cease to rotate. The mark (7) on the pin (6) will point toward the bleed screw (15).
- Continue to turn the pin (6) until the wheels start to turn. Note the position of the spanner.
- Turn the pin (6) back until the wheels start rotating in the opposite direction. Note the position of the spanner.
- Turn the eccentric pin (6) back half way from the noted spanner position.
- Lock the hexagonal nut (5).
- Manually bring the engine to maximum speed. The wheels should not rotate. Repeat the adjustment if necessary.

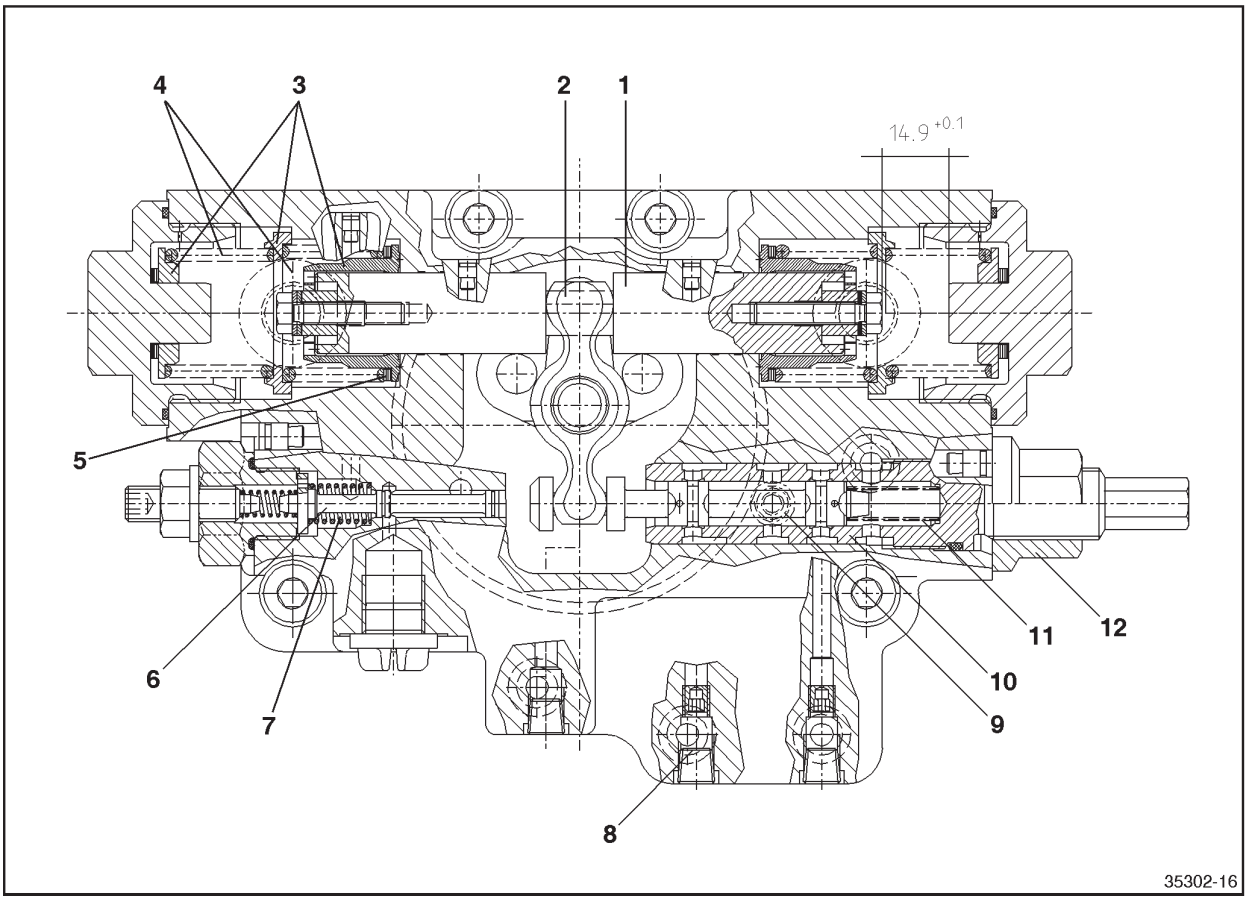
4.2.3.1.2 PRIMARY ADJUSTMENT OF START OF CONTROL

- Let the engine run at low idle speed and slacken the grooved nut (8).
- By turning the setscrew (9), the pressure springs (10) are either tensioned or relieved so that the wheels start to rotate at a differential pressure of 4 bar between Y and Z. The pressure difference must be preset by depressing the accelerator pedals.

4.2.3.1.3 MECHANICAL LIMITATION OF THE SWASHPLATE ANGLE

- Slacken nut (11).
- Start the engine and let it idle.
- Release the brake.
- Screw in the threaded pin (12) with a socket head spanner until the wheels just start to turn.
- In this position measure the distance the threaded pin (12) is behind the front of the setscrew (9).
- Now turn the threaded pin (12) out for 11 mm and lock with the nut (11).

4.2.3.1.4 HYDRAULIC REMOTE CONTROL HPV 105 -02



SERVO CONTROL

1 Control piston
2 Lever
3 Spring plate
4 Spring
5 Shims

REVERSE LOCK-OUT

6 Valve spool
7 Spring

8 Control circuit nozzles

HYDRAULIC ZERO POSITION

9 Pilot
10 Pilot casing (setscrew)
11 Spring
12 Locknut

ADJUSTMENTS

TEST CONDITIONS

- Jack the truck up and secure it safely, so that both drive wheels can spin freely.
- Truck is at operating temperature.
- Travel and braking actuation correctly set.

HYDRAULIC ZERO POSITION

TEST

Test	Findings	Evaluation
Start engine. Release brake, bring engine up to full speed manually.	Wheels stop.	Zero position in order.
	Wheel/s turn.	Zero position not in order. Set in the following manner:

- Raise cover and remove the base plate.
- Loosen the locknut (12) and adjusting screw (10) (pilot casing) using flat spanner with jaw span by turning until the drive wheels stop.
- Continue turning the adjusting screw (10) until the wheels start to turn.
- Mark the spanner position.
- Turn the adjusting screw back until the wheels start turning in the opposite direction.
- Mark the spanner position.
- Turn the adjusting screw (10) back to half of the marked position.
- Tighten the locknut (12).
- Bring the engine up to maximum speed manually. The wheels should not turn.

START OF PRIMARY CONTROL

- Connect a low pressure gauge to ports Y and Z of the remote control.
- Allow the engine to idle at low speed.
- Slowly depress the forward and reverse pedals and determine Δp (specified value: 4 bar) at the start of control (wheels start turning).
- Δp of 4 bar is reached for forwards and reverse: in order.
  Δp <> 4 bar for forward and/or reverse: Set a Δp of 4 bar by means of the shims (5).

REVERSE LOCK-OUT

The response pressure of the reverse lock-out is fixed and cannot not be adjusted.

4.2.3.1.5 REVERSAL LOCK (LOGIC LOCK OUT)

UP TO 4/94

- Slacken the sealing nut (16.2).
- Using a socket head spanner, screw in the setscrew (16.1) as far as possible and then screw out again 2 1/2 to 3 turns.
- Start the engine, release the brake and fully depress the forward accelerator pedal. The engine and wheels must accelerate to full speed. When the direction of travel is reversed quickly (reversing), the engine speed control cylinder is retracted to the bottom end position and held there until the wheels have ceased rotating. Then the speed control cylinder will be extended fully again.
- Perform the same test with the reverse accelerator pedal.

FROM 5/94

- Valve adjustment with shims (16.1.3).
- Start the engine and carry out the test as for the version up to 4/94.

NOTE: Insert the shims: Reversal lock is advanced.
Remove the shims: Reversal lock is retarded.

4.2.3.1.6 REDUCING THE TRUCK SPEED

The maximum truck speed can be reduced as desired by the customer. For this purpose it is only necessary to reduce the travel of the control piston (14), which reduces the swash angle of the pump.

CONDITIONS

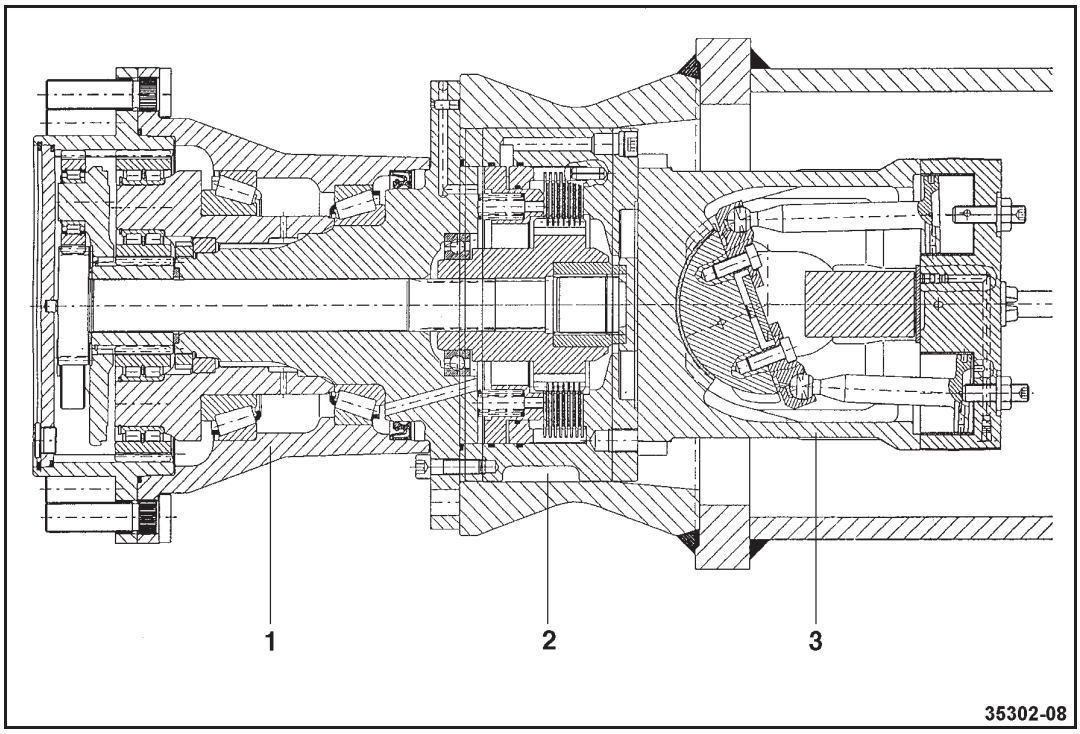
- Truck jacked up and secured with blocks
- Hydraulic oil at operating temperature
- Start of the primary control and the mechanical stop for the swash angle

ADJUSTMENT

- Loosen the ealing collar nut (11) and turn in bolt (12).
  The average RPM of the wheel is reduced by approx. 14.5 rpm, i. e. approx. 2 km/h per turn of th bolt.

Number of Bolt Turns (12)	Average RPM of Wheel	Speed in km/h
0	approx. 160	approx. 24
1	145	22
2	130	20
3	116	18
4	101	16
5	87	14
6	73	12

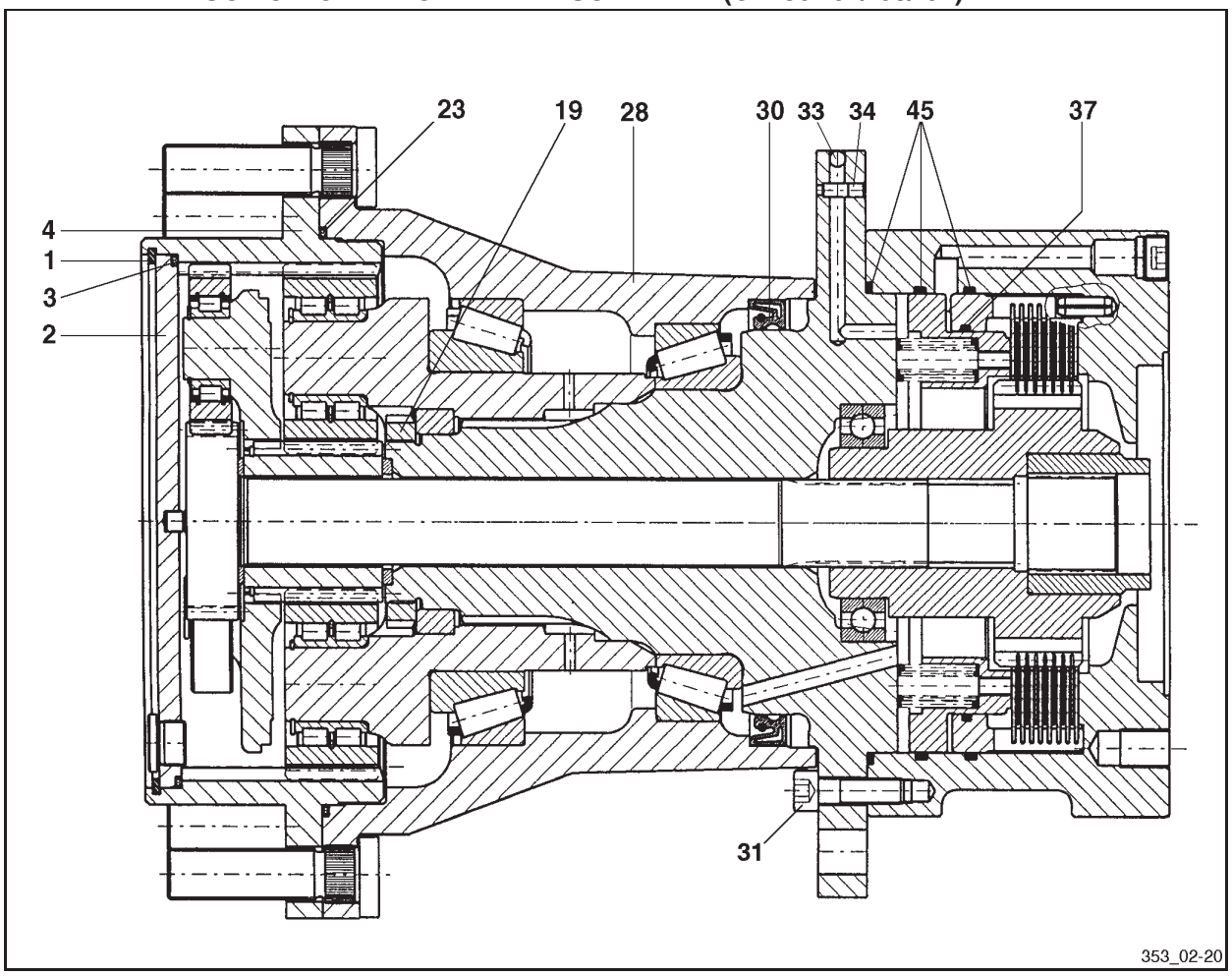
4.2.4 WHEEL DRIVE

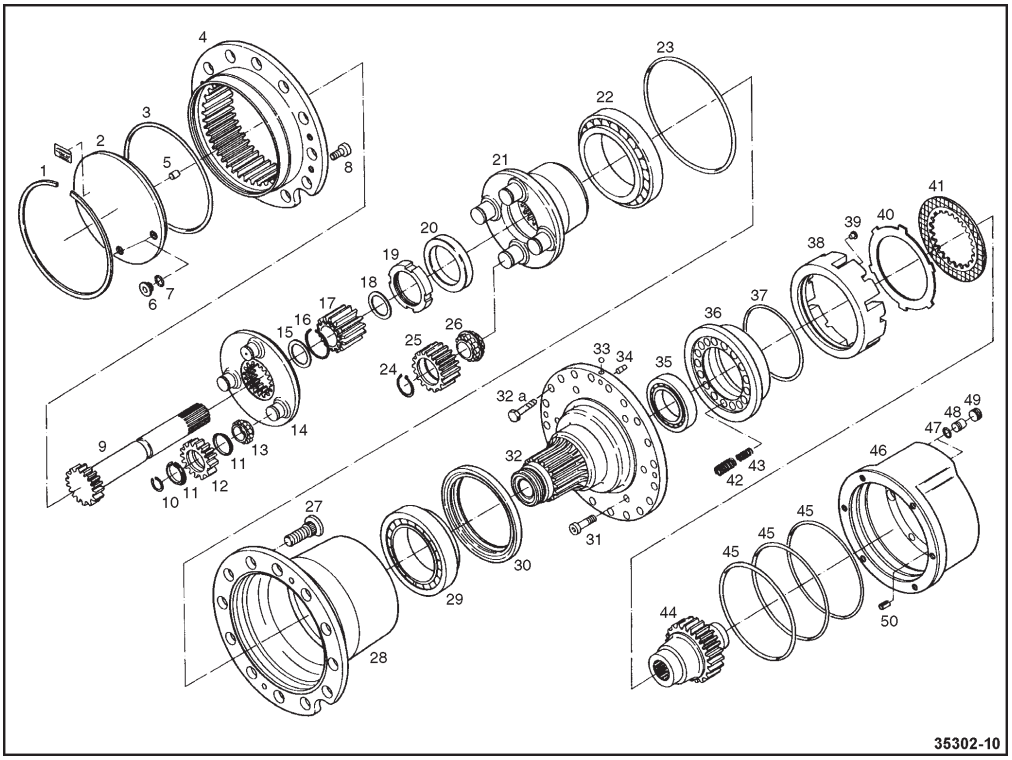


1 Reduction gearbox
2 Disc brake
3 Hydraulic motor

The reduction gearbox and the disc brake can be serviced without removing the complete wheel drive from the truck.
Proceed according to the following instructions.

4.2.4.1 REDUCTION GEARBOX WITH DISC BRAKE (GR 80 -02/-03/-04)





REDUCTION GEARBOX

1 Retaining ring
2 Cover
3 O-ring
4 Ring gear
5 Straight pin
6 Plug
7 Sealing ring
8 Cheese head screw
9 Sun gear shaft I
10 Retaining ring
11 Snap ring
12 Planet spider I
13 Cylindrical roller bearing
14 Planet carrier I
15 Thrust washer
16 Snap ring
17 Sun gear II
18 Thrust washer
19 Grooved nut
20 Centring ring
21 Planet carrier II
22 Taper roller bearing
23 O-ring
24 Retaining ring
25 Planet spider II
26 Cylindrical roller bearing
27 Wheel bolt
28 Wheel hub
29 Taper roller bearing
30 Shaft sealing ring
31 Cheese head screw
32 Axle flange
32a Cheese head screw
33 Ball
34 Sintered metal filter (ventilation)

DISC BRAKE

35 Ball bearing
36 Brake piston
37 O-ring
38 Disc carrier
39 Rivet
40 Disc
41 Disc
42 Spring
43 Spring
44 Pinion
45 O-ring
46 Brake housing
47 O-ring
48 Plug
49 Setscrew
50 Roll pin

4.2.4.2 SERVICING THE REDUCTION GEARBOX (GR 80 -02/-03/-04)

CONDITIONS

- Jack up the truck and block it up securely.
- Remove the traction wheel.
- Place an oil pan under the gearbox.

REPLACING THE SEALING RING (3)

- Tighten the cover (2) using a bar (support on 2 wheel mounting bolts).
- Remove retaining ring (1).
- Remove the bar, take the cover (2) off the ring gear (4) and remove the O-ring (3).
- Installation is the reverse of removal.
- Fill gear oil to the correct level.

REPLACING THE SEALING RING (23)

- Remove the cheese head screws (8).
- Dismantle the ring gear (4) along with parts (1), (2), and (3) from the wheel hub (28) and remove the O-ring (23).
- Installation is the reverse of removal.
- Fill gear oil to the correct level.

REPLACING THE SHAFT SEALING RING (30)

- Remove the cheese head screws (8).
- Dismantle the ring gear (4) along with parts (1), (2), (3) and (23) from the wheel hub (28).
- Extract the sun gear shaft (9) along with the planet carrier items 10 to 17.
- Remove the retaining rings (24) from the planet carrier (21) journal.
- Press the planetary gears (25) off the journal with a mounting iron or a puller.
- Heat the grooved nut (19) and remove with a suitable spanner and torque converter.
  NOTE: The nut (19) is torqued to 2100 Nm and secured with Loctite.
- Pull the planet carrier along with the centring ring (20) and wheel hub (28) from axle flange (32).
- Extract the sealing ring (30) from the hub (28).
- Clean all parts and check for damage.
- Press the sealing ring (30) into the wheel hub with a suitable plate.
- Coat the toothing of the axle flange (32) with grease.
- Slide the wheel hub (28) and planet carrier (21) onto the axle flange (32) so that the axles of the planetary gears are horizontal.
- Coat the thread of nut (19) with Loctite 270 and torque the nut to 2100 Nm.
- Turn the wheel hub about 10 times and hit the outer circumference of the hub several times with a plastic hammer for better seating.
- Retighten the nut with a torque of 2100 Nm.
- Assembly of the planetary hub reduction gear is the reverse of removal. Renew seals (23) and (3).
- Fill gear oil to the correct level.

4.2.4.3 DISC BRAKE REPAIRS

CONDITIONS

- Jack up the truck and block it up safely.
- Remove the traction wheel.
- Place an oil pan under the gearbox.

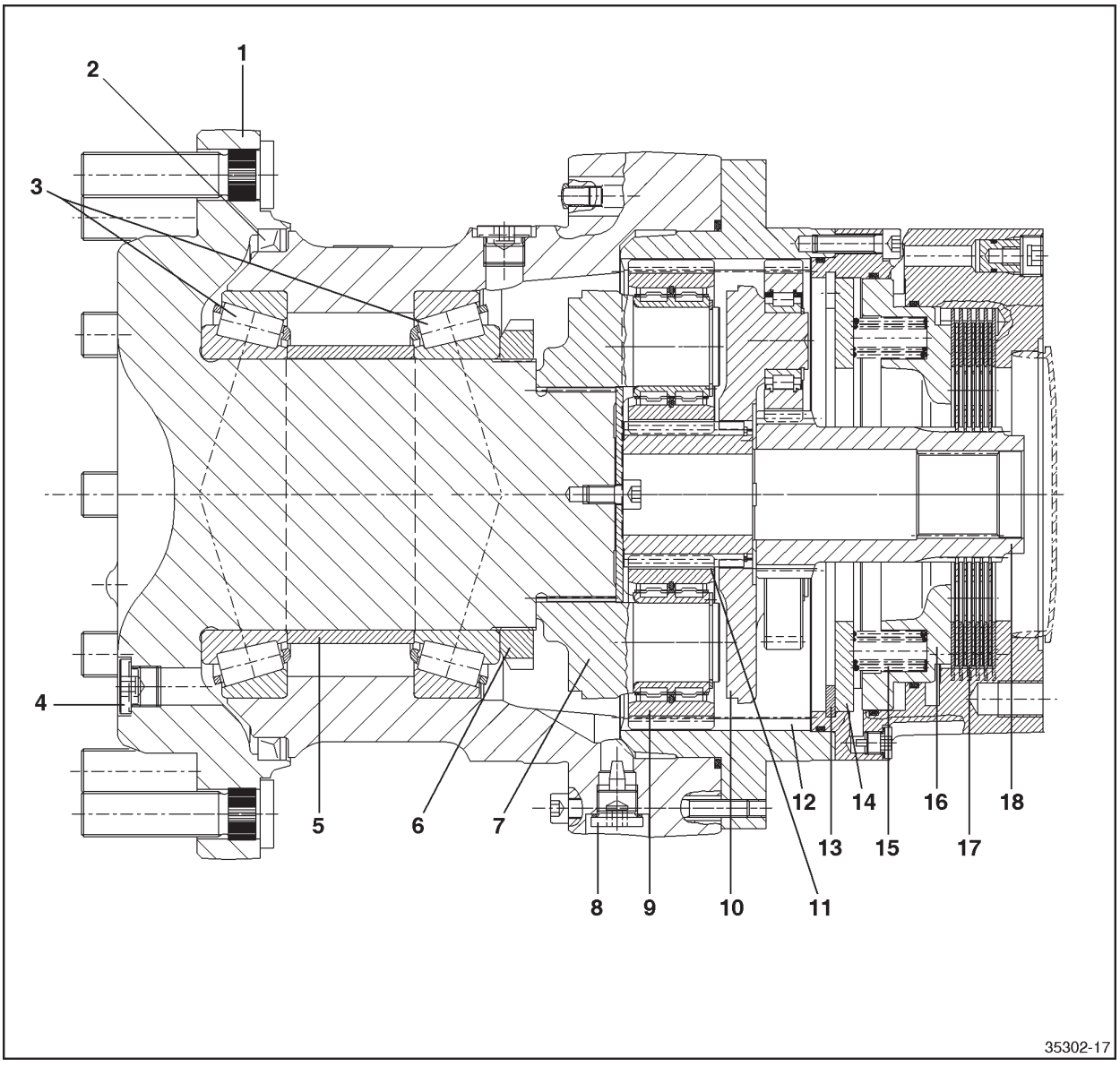
DISC BRAKE REMOVAL

- Drive a pedestrian pallet truck under the gearbox, raise the gearbox and place a suitable wooden support under it in the centre.
- Drive a wooden wedge under the mounting of the manifold to prevent the motor from tipping.
- Unscrew the M16x40 mounting screws (32a).
- Remove the M10x35 cheesehead screw (31) to detach the gearbox assembly from the housing (46) and drive the pallet truck away.
- Remove springs (42) and (43), extract brake piston (36) from the housing (46) with 2 M8 bolts.
- Remove the first O-ring (45) from the brake housing (46), extract the pinion (44) and the disc carrier (38) from the brake housing (46) with a two-pronged puller.
- Remove the second O-ring (45) and O-ring (37).

DISC BRAKE INSTALLATION

- Install the inner O-ring (45) into the brake housing (46).
- Slide the pinion (44) onto the hydraulic motor output shaft.
- Mark the position of the roll pin (50) in relation to the holes in the disc carrier (38).
- Introduce the disc carrier into the housing (46) and slide the discs with 2 small screwdrivers bit for bit over the toothing of the pinion (44). The disc carrier must always be pressed in further.
- The mounting depth of the disc carrier is correct if the inlet of the release oil (in the housing (46)) is flush with the outer edge of the carrier.
- Insert the outer O-ring (45) into the brake housing (46) and O-ring (37) into the planet carrier (38).
- Screw two M10x100 guide pins into opposite sides of the brake housing (46).
- Place the compression springs (42) and (43) into the spool (36). The two drilled holes on the opposite side are not used.
- Using the guide pins, fit the planetary hub reduction gear on the brake housing (46) and fasten it to the housing with two opposite M10x60 cheesehead screws.
- Remove the guide pins and screw in the original M8x40 screws.
- Screw in and tighten the screws (32a).
- Fill gear oil to the correct level.
- Start the engine and perform a brake test. Mount the traction wheel and lower the truck to the ground.

4.2.4.4 REDUCTION GEARBOX GR 80 -06 WITH MULTIPLE DISC BRAKE



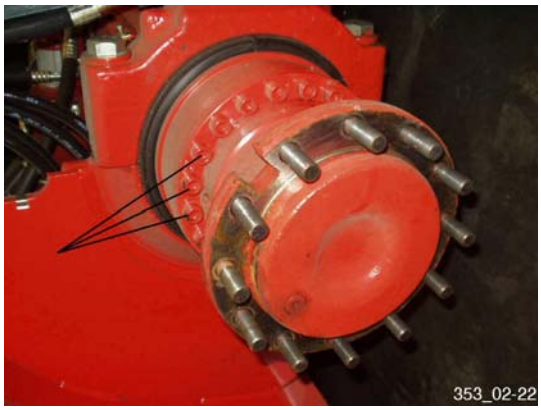
1 Wheel hub
2 Shaft seal
3 Tapered roller bearing
4 Plug
5 Pretensioning ring
6 Slotted nut
7 Planetary carrier II
8 Drain plug
9 Planetary gears
10 Planetary carrier I
11 Sun gear
12 Internal gear
13 Circlip
14 Pretensioning plate
15 Brake springs
16 Brake piston
17 Brake discs
18 Pinion

4.2.4.5 REPAIR ON THE REDUCING GEAR GR 80 -06

DISMOUNTING

Jack up truck and dismount wheel.

Unscrew the hexagon socket screw.

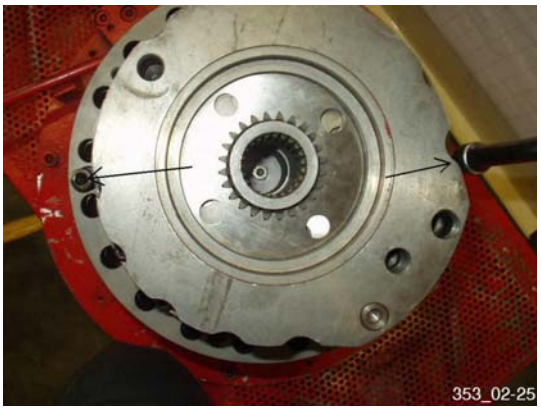


Loosen gear unit from oil motor and remove it.

Put appropriate device under oil motor in retainer of motor carrier (cramped working conditions) in order to avoid tilting.

Fasten gear unit for dismounting and unscrew the hexagon socket screws.

2x unscrew hexagon socket screw (arrows).



Remove casing.

Dismount planetary carrier 2nd stage.
The hexagon socket screw is pasted in by means of Loctite. Heat to unscrew.
Pull out planetary carrier with 4 gearwheels.

Loosen groove nut.
Tightening torque 5300 $^{+200}$ Nm.
The groove nut is pasted in with Loctite. Heat to loosen groove nut.

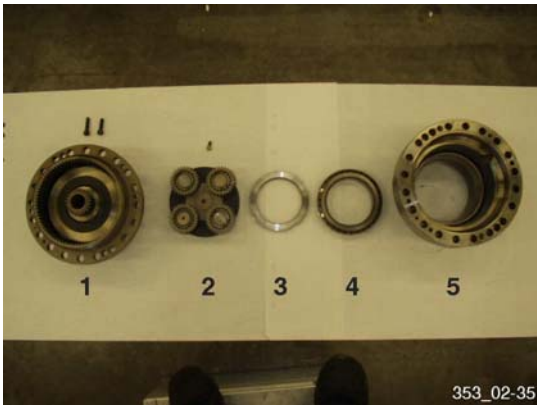
Groove nut spanner for gear unit GR 80 -06
Purchse order number 399 900 70 79
Required to unscrew groove nut.

Pull off casing.
Screw mounting rail on casing.
Put threaded rod on drive shaft.

Renew radial shaft seal (arrow).
Dismount securing ring. The radial shaft seal is pasted in with Loctite.

Dismounting sequence:

1 Casing with multi-disc brake
2 Planetary carrier 2
3 Groove nut
4 Taper roller bearing
5 Casing



MOUNTING

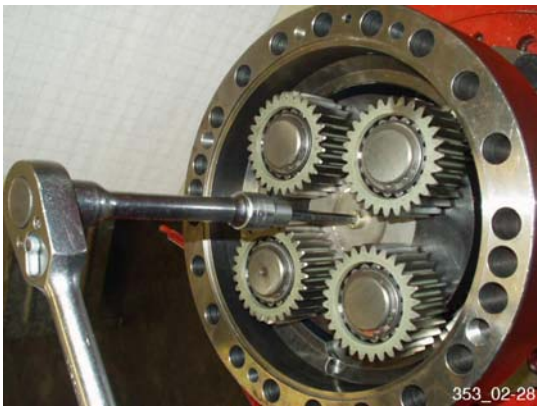
Put Loctite on the outer ring of the radial shaft seal, insert it, press in by means of press-in tool 399 900 70 75 or hammer in.

Heat taper roller bearing and insert it.

Screw in groove nut with chamfer pointing downwards.

Cover groove nut with Loctite FK2 and tighten with 5300 $^{+200}$ Nm.

Plug in planetary carrier 2, cover screw with Loctite FK2 and tighten with a tightening torque of 23 Nm.



Plug in planetary carrier 1.

Plug in pinion.

1 Casing with multi-disc brake
2 Pinion
3 Planetary carrier 1

Install casing.

Note
Pinion must be inserted in toothing of multi-disc brake.

Adjustment by turning the lower gear casing.
Assemble and install in truck.

4.2.5 TROUBLESHOOTING

4.2.5.1 CONNECTING DIAGRAM FOR TROUBLESHOOTING

LEGEND TO DIAGRAM

BR Travel control outlet -> brake inlet

E Power limiter outlet -> inlet of travel control and remote control for hydraulic motors

E1 Power limiter inlet

F Travel control outlet -> speed control cylinder and remote control inlet for hydraulic motors

N Reversing lock outlet -> inlet of speed control cylinder and power limiter

P3 Hydraulic oil filter inlet

P4 Hydraulic oil filter outlet

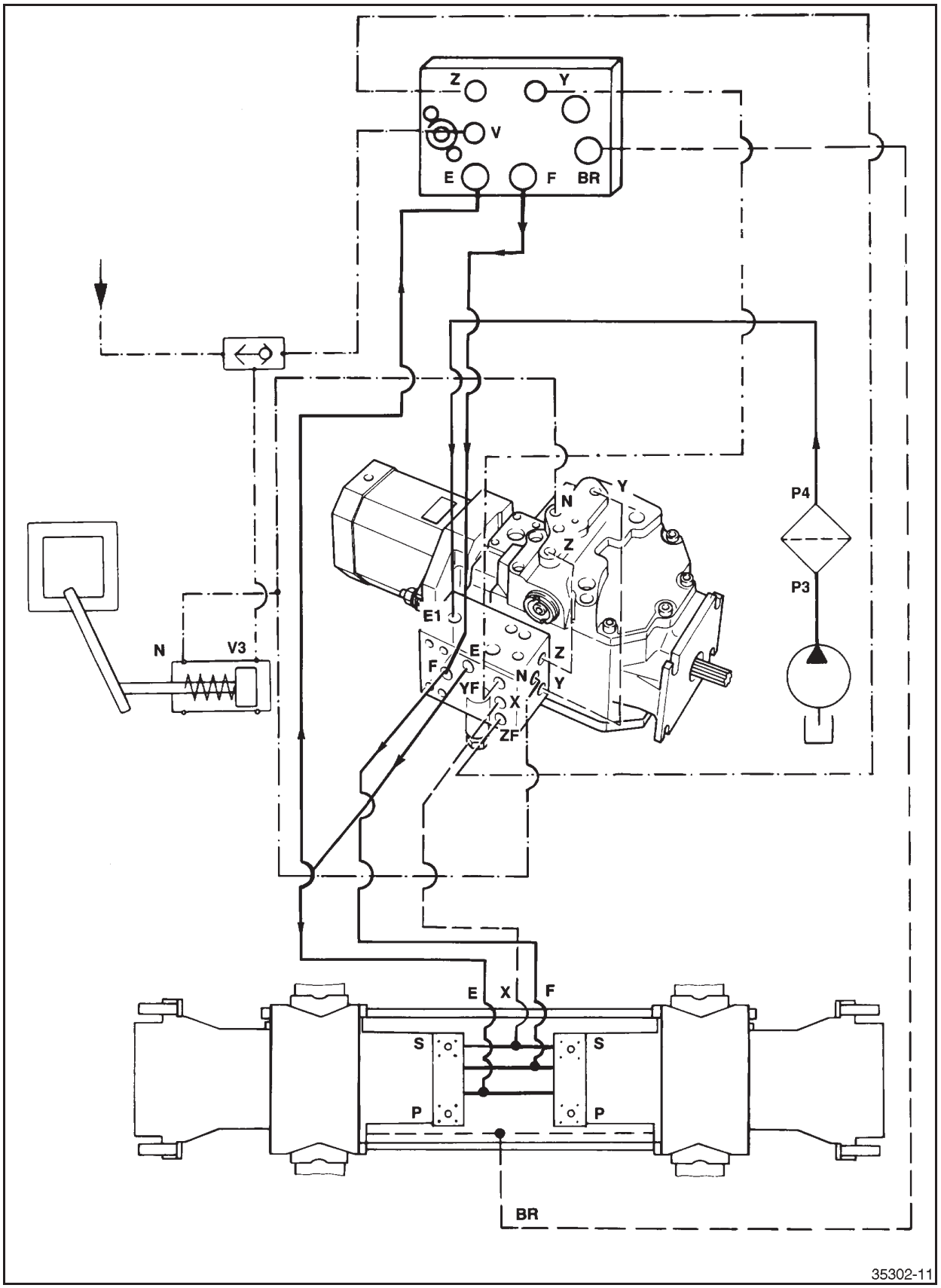
V Travel control outlet -> speed control cylinder inlet

X Power limiter -> inlet of remote control for hydraulic motors

Y/Z Travel control outlet -> YF/ZF power limiter

Y/Z Power limiter outlet -> inlet of remote control for variable-displacement pump

S/P High pressure ports on hydraulic motors


Z
Y
V
E
F
BR
N
Y
Z
E1
P4
P3
N
V3
F
E
Z
N
Y
YF
X
ZF
E
X
F
S
S
P
P
BR
35302-11

4.2.5.2 TOOLS AND AIDS FOR MEASUREMENTS

The tools and gauges used for troubleshooting are similar to the ones in the catalogue "Special Tools and Instruments".
The part names are the same as those in the catalogue under the same consecutive number. All parts contained in the test box are also identified by "1." in the description of the troubleshooting. The rest of the designation corresponds to the identification of the test box manufacturer.
Example: Text box designation "banjo bolt 7 a" = troubleshooting designation "banjo bolt 1.7 a"

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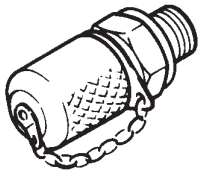
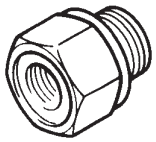
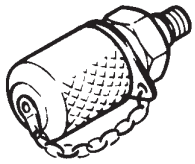
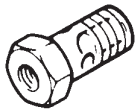
  </td><td>1.3
  </td><td>1.5
  </td><td>1.7 a
  </td></tr>
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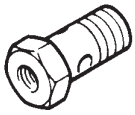
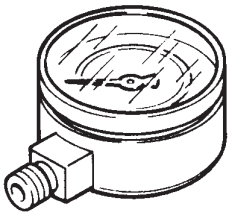
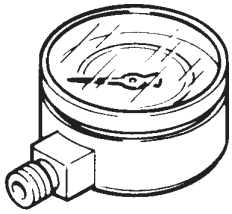
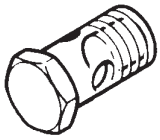
  </td><td>1.12
  </td><td>1.13
  </td><td>1.17
  </td></tr>
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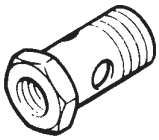
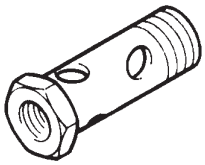
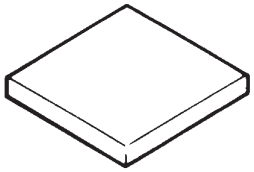
  </td><td>1.19
  </td><td>1.24
  </td><td></td></tr>
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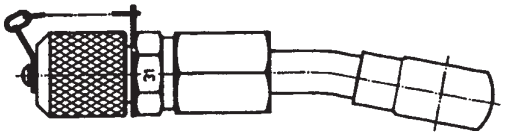
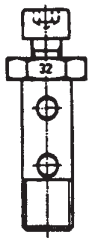
  </td><td>1.32
  </td><td>35302-12</td></tr>
</table>

ITEM NO.	DESCRIPTION
1.1	Screw coupling M 14 x 1.5
1.3	Adapter nipple
1.5	Screw coupling M 8 x 1
1.7 a	Banjo bolt M 14 x 1.5 with plug and M 8 x 1 bore
1.7 b	Banjo bolt M 14 x 1.5 with M 8 x 1 bore
1.12	Low pressure gauge 0 - 40 bar
1.13	High pressure gauge 0 - 600 bar
1.17	Banjo bolt M 18 x 1.5 with plug
1.18	Banjo bolt M 18 x 1.5 with M 14 x 1.5 bore
1.19	Banjo bolt M 18 x 1.5 with M 14 x 1.5 bore
1.24	Cover plate 50 x 38
1.31	Round connector
1.32	Banjo bolt with shut-off valve

ADAPTER NO.	CONSISTING OF:
I	Adapter nipple 1.3 Screw coupling 1.1
II	Banjo bolt 1.7 a Screw coupling 1.5
III	Banjo bolt 1.7 b Screw coupling 1.5
IV	Banjo bolt 1.18 Screw coupling 1.1
V	Banjo bolt 1.19 Screw coupling 1.1

4.2.5.3 EXPLANATIONS TO TROUBLESHOOTING

The functional tests and any ensuing troubleshooting is performed separately for each main group. The following components and functions are affected:

4.2.5.4 Hydraulic speed control for the engine
4.2.5.5 Hydraulic braking system
4.2.5.6 Pressure equality and start of control
4.2.5.7 Hydrostatic travel drive

Before commencing with the activities described below, first check the oil level and top up, if required.

If a pressure gauge or a plug must be installed for a test procedure, first depressurize the tank by unscrewing the breather valve.

The installation points for pressure gauges or plugs are shown in the line hook-up diagram.

In some test steps the hydraulic motors must be disconnected. In this case proceed as follows:

Loosen the high pressure flange fastening screws of the hydraulic motor to be disconnected by about 5 turns, pull back the hoses, slide the cover plate 1.24 (50 x 38) between the motor flange surface and the sealing surface of the piping (pay attention to the O-rings) and tighten the screws.

List of abbreviations used

LP gauge = low pressure gauge
HP gauge = high pressure gauge
LP = low pressure
HP = high pressure
F pedal = forward accelerator pedal
R pedal = reverse accelerator pedal
Δp = pressure difference
PL = power limiter

If not specified otherwise, all pressure measurements must be performed with the brake pedal released.

4.2.5.4 HYDRAULIC SPEED CONTROL FOR THE ENGINE

The engine speed control check is first performed, as described below, merely as a functional test. If any malfunctions are detected during the test, a detailed troubleshooting must be carried out subsequently.

4.2.5.4.1 FUNCTIONAL TEST

TEST CONDITIONS

- Engine and travel drive at operating temperature
- Pedals properly adjusted

TEST

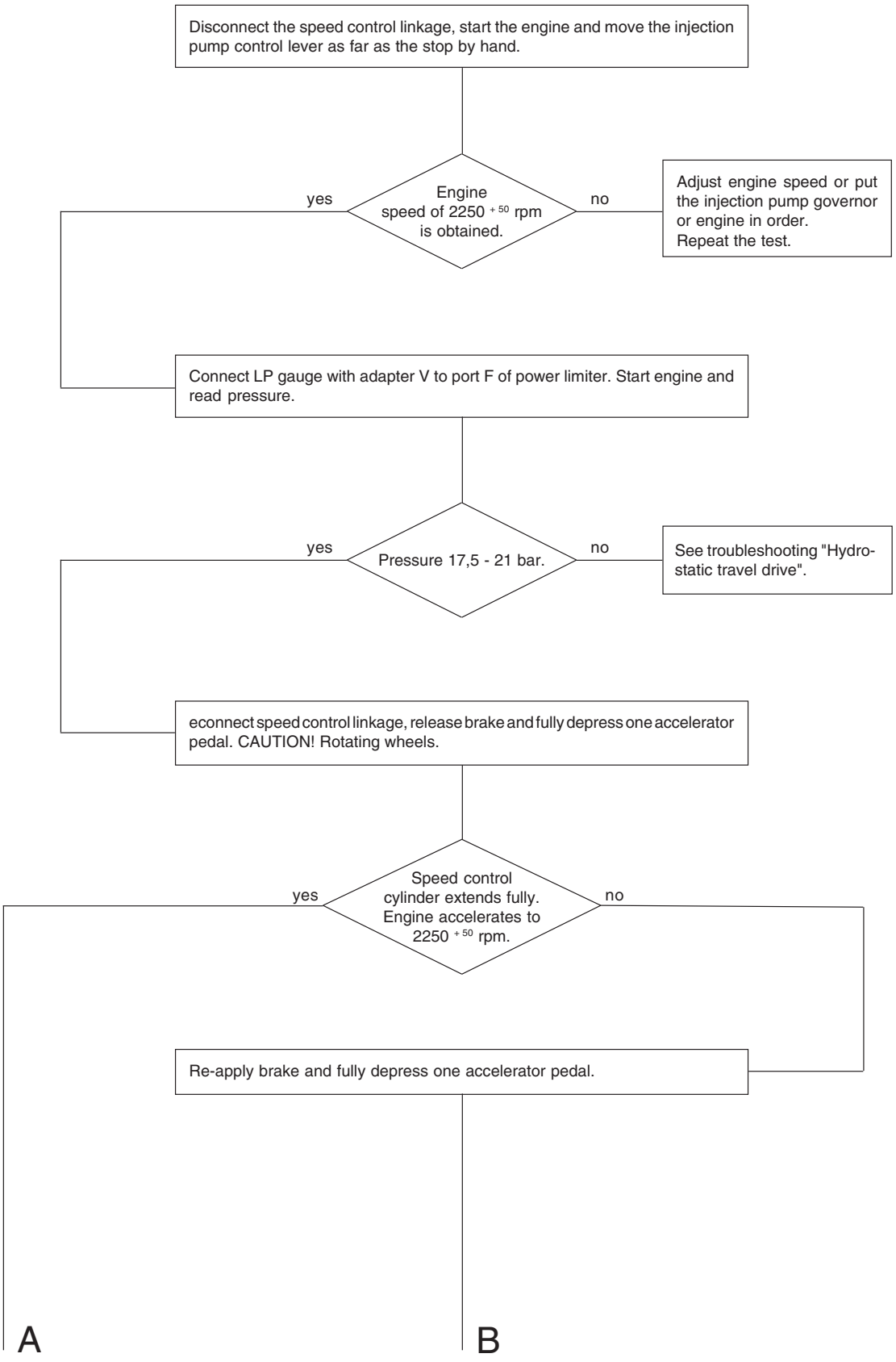
Prüfung	Symptoms	Assessment
Start the engine and, with the brake applied, fully depress the F and R accelerator pedals. Then, with the pedal released, move the lift lever to the "Lift" position, hold there and then release the lever. Release the brake, fully depress the F and R accelerator pedals consecutively and release them. **Caution:** Rotating wheels!	Each time the engine speed control cylinder moves the injection pump lever as far as the stop. Engine speed reaches the upper idling speed of 2250 $^{+50}$ RPM and then drops to the lower idling speed of 750 $^{+50}$ RPM.	Speed control is in order.

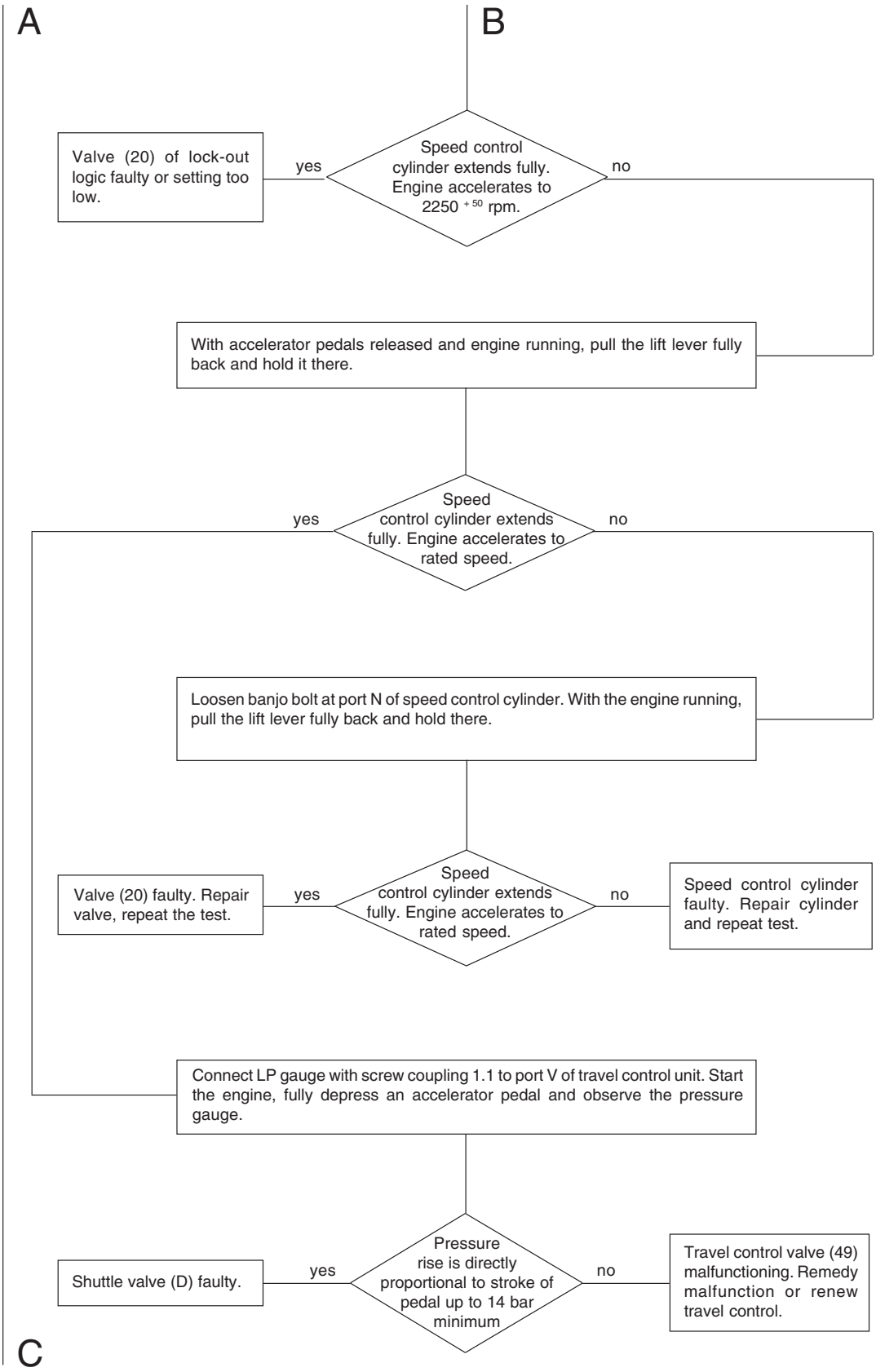
If these results are not obtained, or the engine does not accelerate when driving, determine and eliminate the cause as follows.

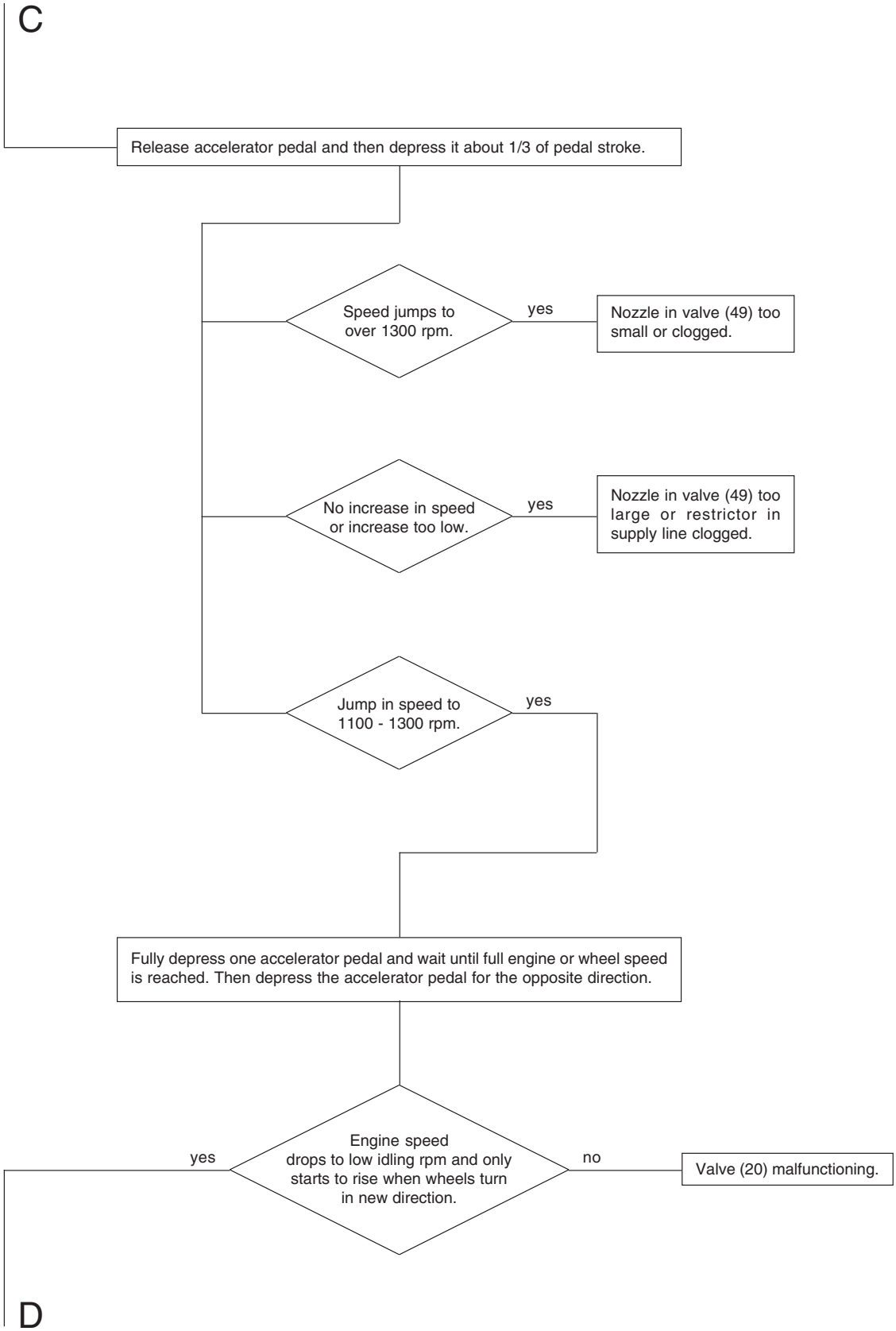
4.2.5.4.2 TROUBLESHOOTING

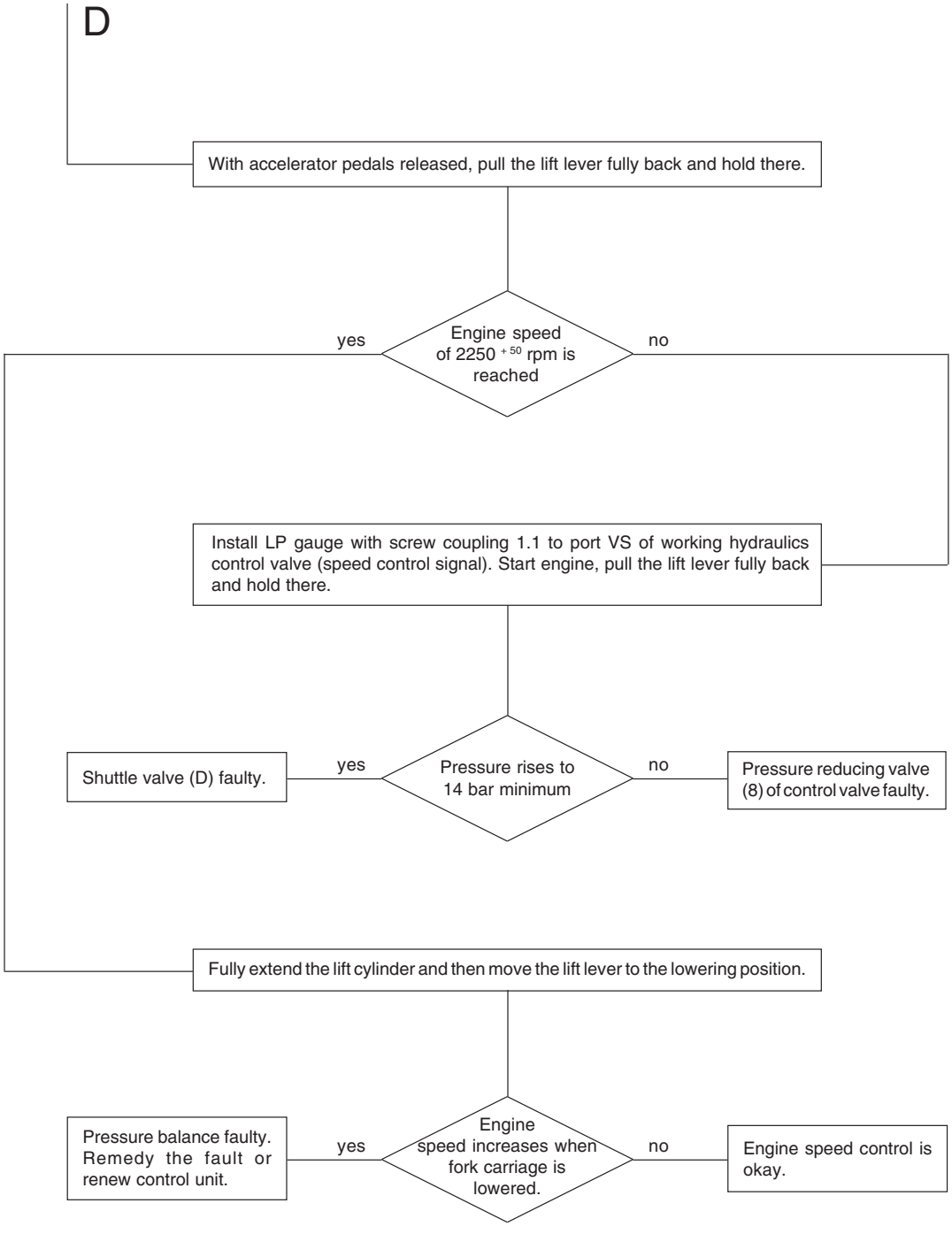
TEST CONDITIONS

- Pedals properly adjusted.
- Engine and travel drive at operating temperature.
- Engine cover raised.
- Floor plate removed.
- Front cover removed.
- Brake pedal locked in the "applied" position.
- Truck jacked up and secured so that both traction wheels can rotate freely.


Disconnect the speed control linkage, start the engine and move the injection pump control lever as far as the stop by hand.
Engine speed of 2250 +50 rpm is obtained.
yes
no
Adjust engine speed or put the injection pump governor or engine in order. Repeat the test.
Connect LP gauge with adapter V to port F of power limiter. Start engine and read pressure.
Pressure 17,5 - 21 bar.
yes
no
See troubleshooting "Hydrostatic travel drive".
econnect speed control linkage, release brake and fully depress one accelerator pedal. CAUTION! Rotating wheels.
Speed control cylinder extends fully. Engine accelerates to 2250 +50 rpm.
yes
no
Re-apply brake and fully depress one accelerator pedal.
A
B


A
B
Speed control cylinder extends fully. Engine accelerates to 2250 +50 rpm.
yes
Valve (20) of lock-out logic faulty or setting too low.
no
With accelerator pedals released and engine running, pull the lift lever fully back and hold it there.
Speed control cylinder extends fully. Engine accelerates to rated speed.
yes
no
Loosen banjo bolt at port N of speed control cylinder. With the engine running, pull the lift lever fully back and hold there.
Speed control cylinder extends fully. Engine accelerates to rated speed.
yes
Valve (20) faulty. Repair valve, repeat the test.
no
Speed control cylinder faulty. Repair cylinder and repeat test.
Connect LP gauge with screw coupling 1.1 to port V of travel control unit. Start the engine, fully depress an accelerator pedal and observe the pressure gauge.
Pressure rise is directly proportional to stroke of pedal up to 14 bar minimum
yes
Shuttle valve (D) faulty.
no
Travel control valve (49) malfunctioning. Remedy malfunction or renew travel control.
C


C
Release accelerator pedal and then depress it about 1/3 of pedal stroke.
Speed jumps to over 1300 rpm.
yes
Nozzle in valve (49) too small or clogged.
No increase in speed or increase too low.
yes
Nozzle in valve (49) too large or restrictor in supply line clogged.
Jump in speed to 1100 - 1300 rpm.
yes
Fully depress one accelerator pedal and wait until full engine or wheel speed is reached. Then depress the accelerator pedal for the opposite direction.
Engine speed drops to low idling rpm and only starts to rise when wheels turn in new direction.
yes
no
Valve (20) malfunctioning.
D


D
With accelerator pedals released, pull the lift lever fully back and hold there.
Engine speed of 2250 +50 rpm is reached
yes
no
Install LP gauge with screw coupling 1.1 to port VS of working hydraulics control valve (speed control signal). Start engine, pull the lift lever fully back and hold there.
Pressure rises to 14 bar minimum
yes
no
Shuttle valve (D) faulty.
Pressure reducing valve (8) of control valve faulty.
Fully extend the lift cylinder and then move the lift lever to the lowering position.
Engine speed increases when fork carriage is lowered.
yes
no
Pressure balance faulty. Remedy the fault or renew control unit.
Engine speed control is okay.

4.2.5.5 HYDRAULIC BRAKING SYSTEM

4.2.5.5.1 FUNCTIONAL TEST

TEST CONDITIONS

- Truck jacked up and secured so that both traction wheels can rotate freely.
- Pedals properly adjusted.
- Brake pedal locked in the "brake applied" position
- Hydraulic oil at operating temperature

TEST

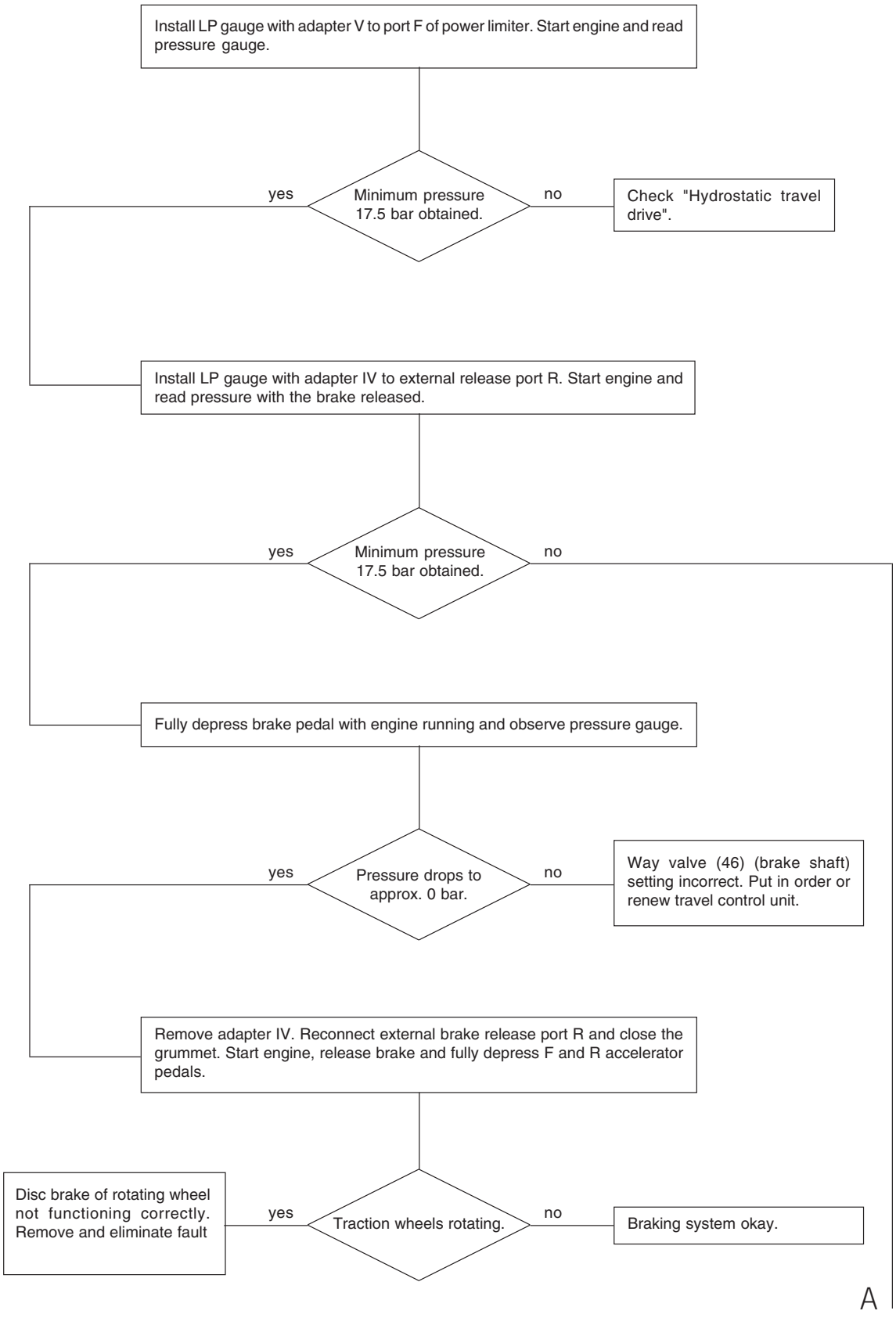
Test	Symptoms	Assessment
Start engine and attempt to turn right or left traction wheel with wheel nut spanner and extension.	Traction wheels cannot be turned.	Parking brake system is okay.
Release brake pedal and try to turn right or left traction wheel again.	Traction wheels can be turned.	

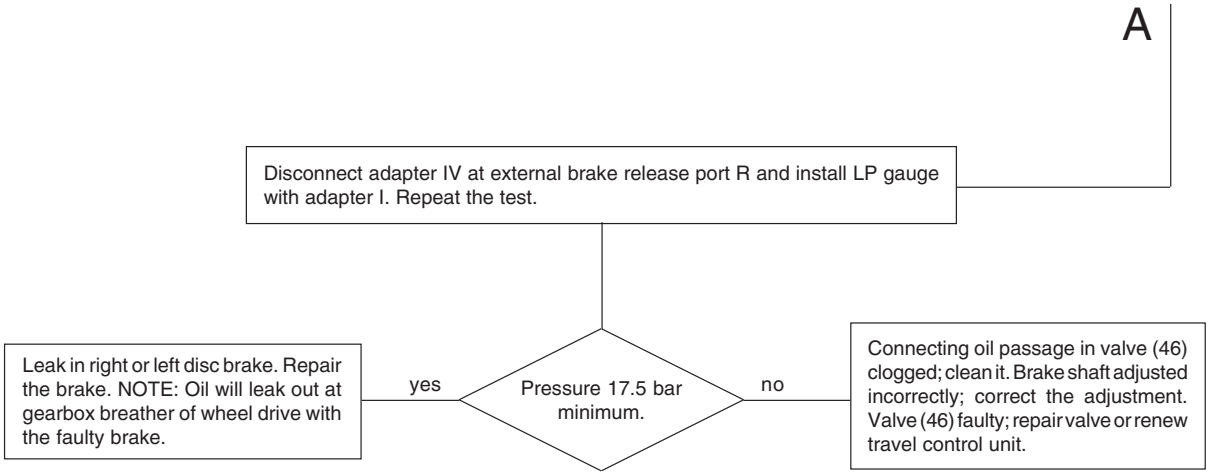
After this test, lower the truck and check the braking behaviour of the rolling vehicle.
Perform this check by fully depressing the brake pedal when an accelerator pedal is fully depressed. The wheels must lock without the truck pulling to one side. If the result of the test is not as described, determine the cause by troubleshooting and remedy the fault

4.2.5.5.2 TROUBLESHOOTING

TEST CONDITIONS

- Truck jacked up and secured so that both traction wheels can rotate freely.
- Engine cover raised.
- Floor plate removed.
- Pedals properly adjusted.
- Engine and travel drive at operating temperature.
- Front cover removed.
- Brake pedal locked in the "applied" position.


Install LP gauge with adapter V to port F of power limiter. Start engine and read pressure gauge.
Minimum pressure 17.5 bar obtained.
yes
no
Check "Hydrostatic travel drive".
Install LP gauge with adapter IV to external release port R. Start engine and read pressure with the brake released.
Minimum pressure 17.5 bar obtained.
yes
no
Fully depress brake pedal with engine running and observe pressure gauge.
Pressure drops to approx. 0 bar.
yes
no
Way valve (46) (brake shaft) setting incorrect. Put in order or renew travel control unit.
Remove adapter IV. Reconnect external brake release port R and close the grummet. Start engine, release brake and fully depress F and R accelerator pedals.
Traction wheels rotating.
yes
no
Disc brake of rotating wheel not functioning correctly. Remove and eliminate fault
Braking system okay.
A


A
Disconnect adapter IV at external brake release port R and install LP gauge with adapter I. Repeat the test.
Pressure 17.5 bar minimum.
yes
Leak in right or left disc brake. Repair the brake. NOTE: Oil will leak out at gearbox breather of wheel drive with the faulty brake.
no
Connecting oil passage in valve (46) clogged; clean it. Brake shaft adjusted incorrectly; correct the adjustment. Valve (46) faulty; repair valve or renew travel control unit.

4.2.5.6 PRESSURE EQUALITY AND START OF CONTROL

TEST CONDITIONS

- Truck not jacked up.
- Pedals properly adjusted.
- Brake released.
- Engine and travel drive at operating temperature.

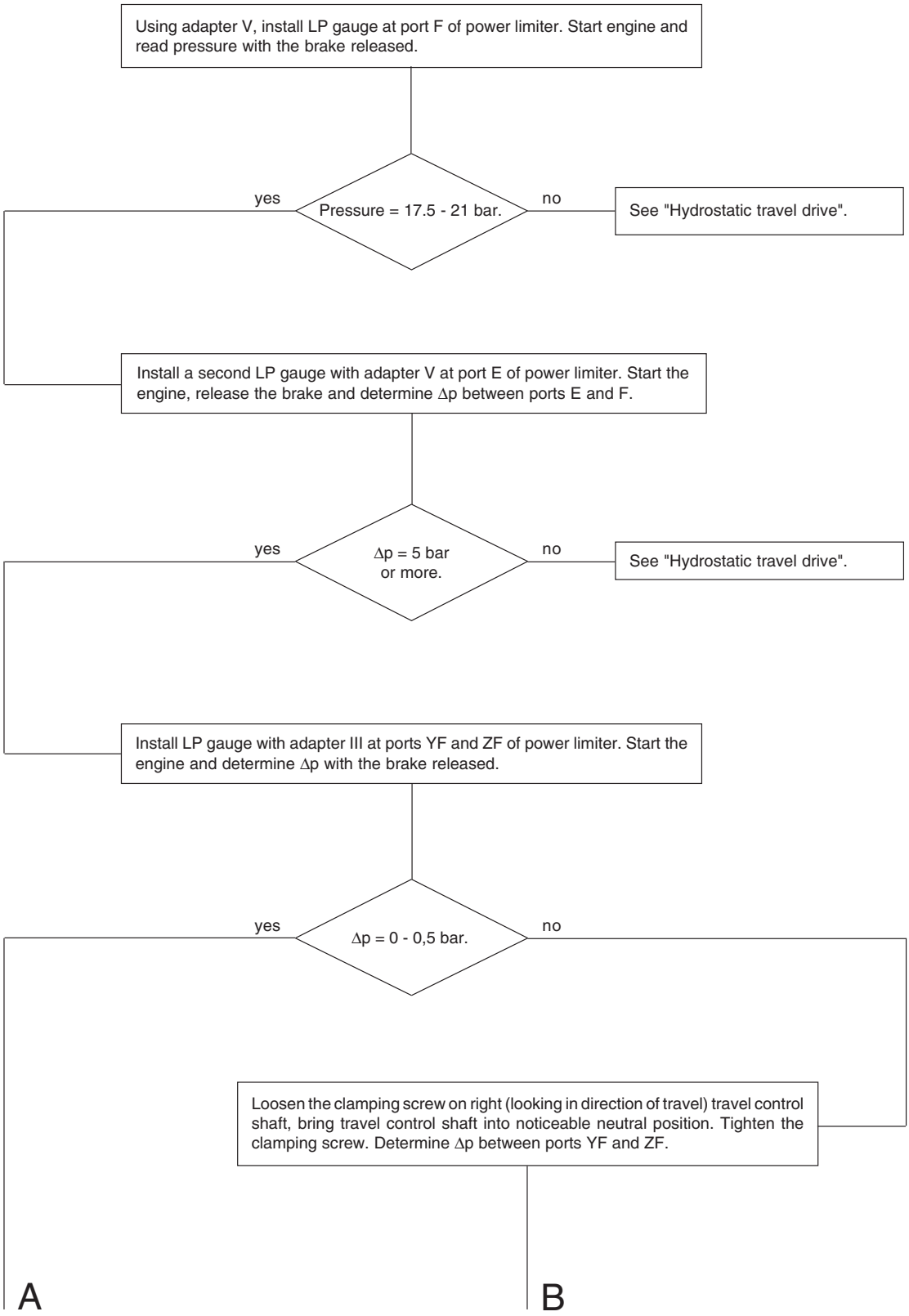
4.2.5.6.1 FUNCTIONAL TEST

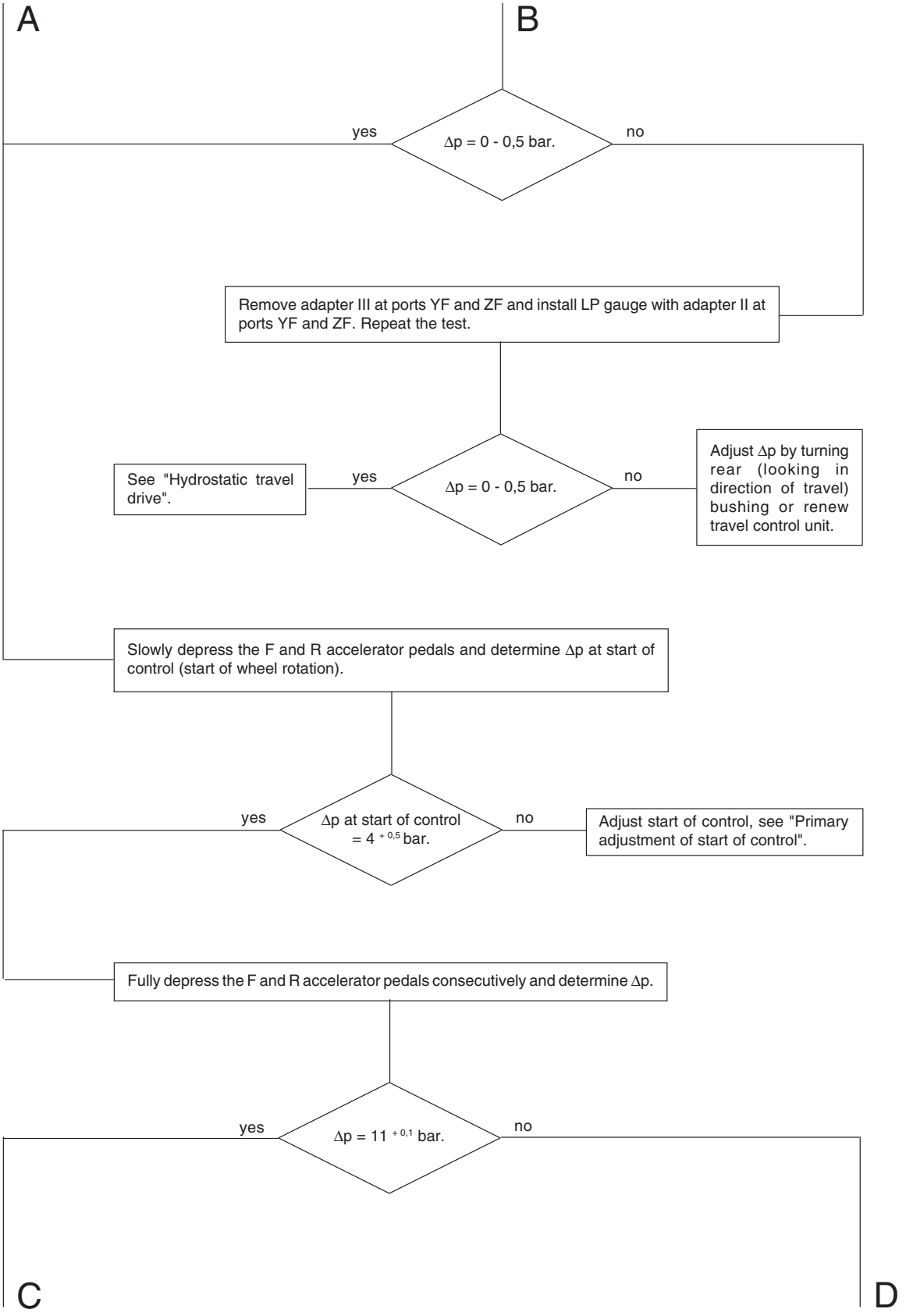
- Driver seated on driver's seat
- Start engine

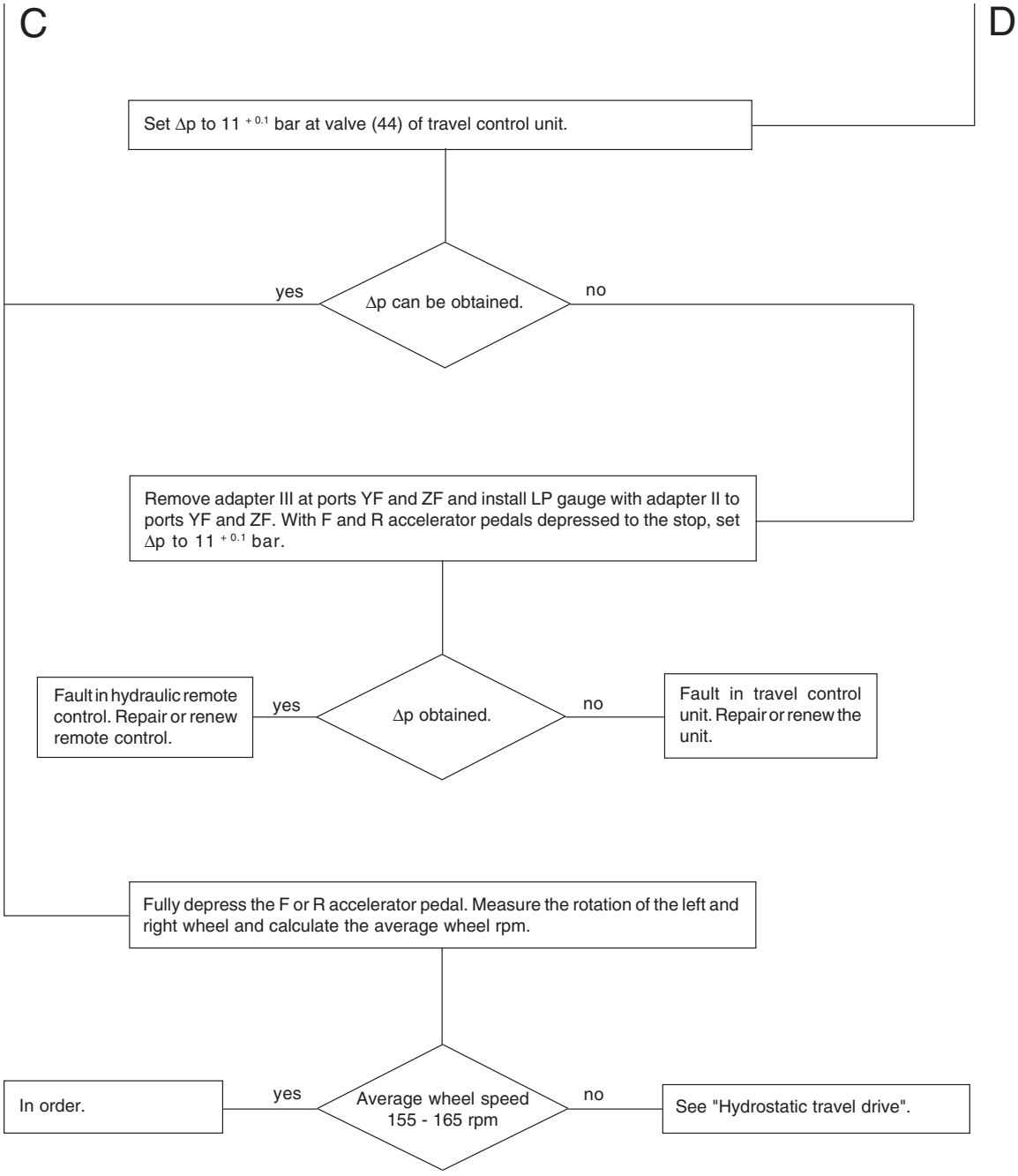
Test	Symptoms	Beurteilung
Sensitively depress F or R accelerator pedal (fine control range) until truck starts.	Truck starts slowly without jerking.	Start of control okay.
	Truck jerks.	Start of control not okay Perform troubleshooting acc. to following procedures.

4.2.5.6.2 TROUBLESHOOTING

- Jack up and secure the truck so that both traction wheels can rotate freely.
- Remove the front cover.
- Remove the floor plate.


Using adapter V, install LP gauge at port F of power limiter. Start engine and read pressure with the brake released.
yes
Pressure = 17.5 - 21 bar.
no
See "Hydrostatic travel drive".
Install a second LP gauge with adapter V at port E of power limiter. Start the engine, release the brake and determine Δp between ports E and F.
yes
Δp = 5 bar or more.
no
See "Hydrostatic travel drive".
Install LP gauge with adapter III at ports YF and ZF of power limiter. Start the engine and determine Δp with the brake released.
yes
Δp = 0 - 0,5 bar.
no
Loosen the clamping screw on right (looking in direction of travel) travel control shaft, bring travel control shaft into noticeable neutral position. Tighten the clamping screw. Determine Δp between ports YF and ZF.
A
B

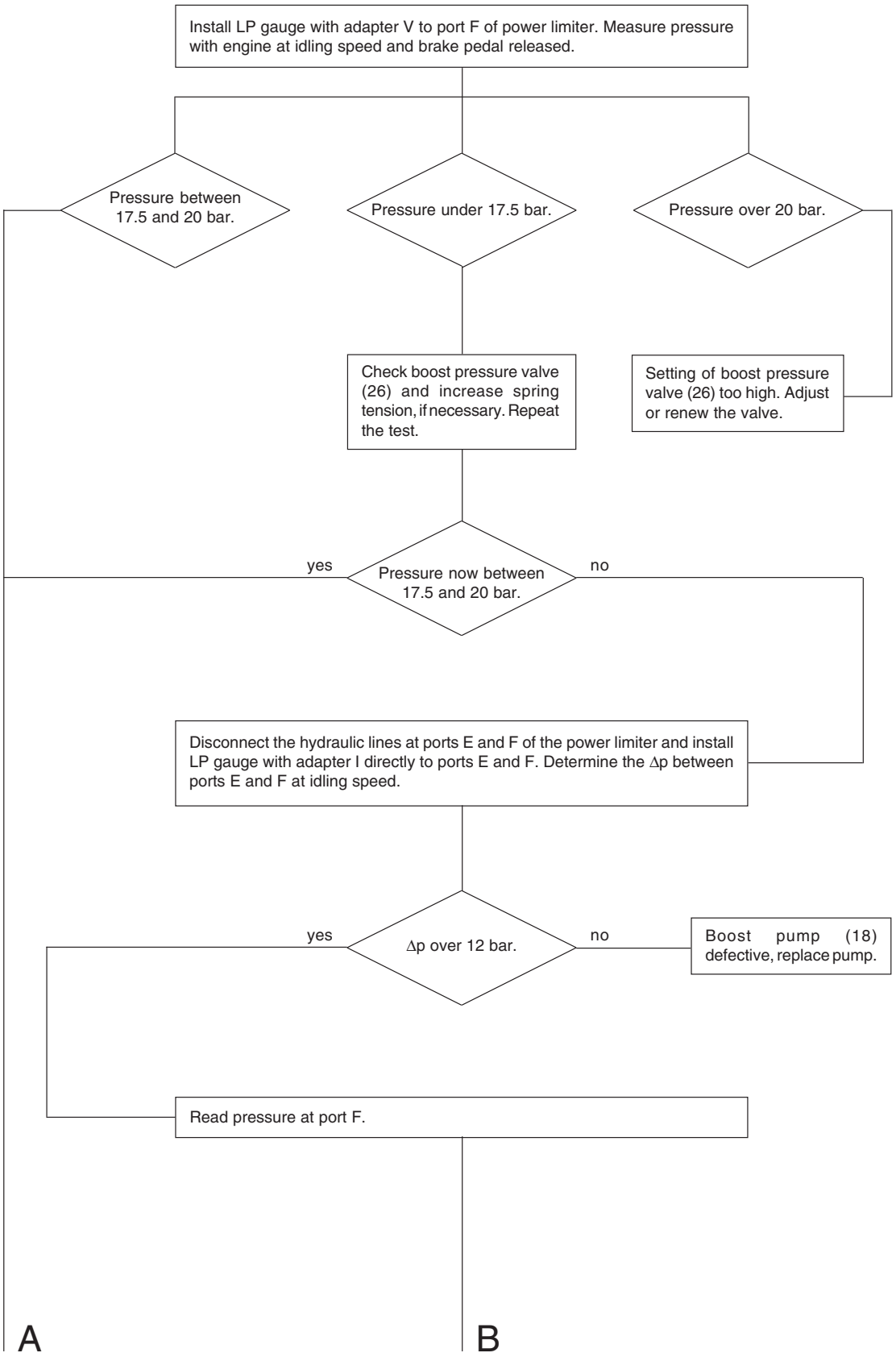

A
B
yes
Δp = 0 - 0,5 bar.
no
Remove adapter III at ports YF and ZF and install LP gauge with adapter II at ports YF and ZF. Repeat the test.
See "Hydrostatic travel drive".
yes
Δp = 0 - 0,5 bar.
no
Adjust Δp by turning rear (looking in direction of travel) bushing or renew travel control unit.
Slowly depress the F and R accelerator pedals and determine Δp at start of control (start of wheel rotation).
yes
Δp at start of control = 4 +0,5 bar.
no
Adjust start of control, see "Primary adjustment of start of control".
Fully depress the F and R accelerator pedals consecutively and determine Δp.
yes
Δp = 11 +0,1 bar.
no
C
D

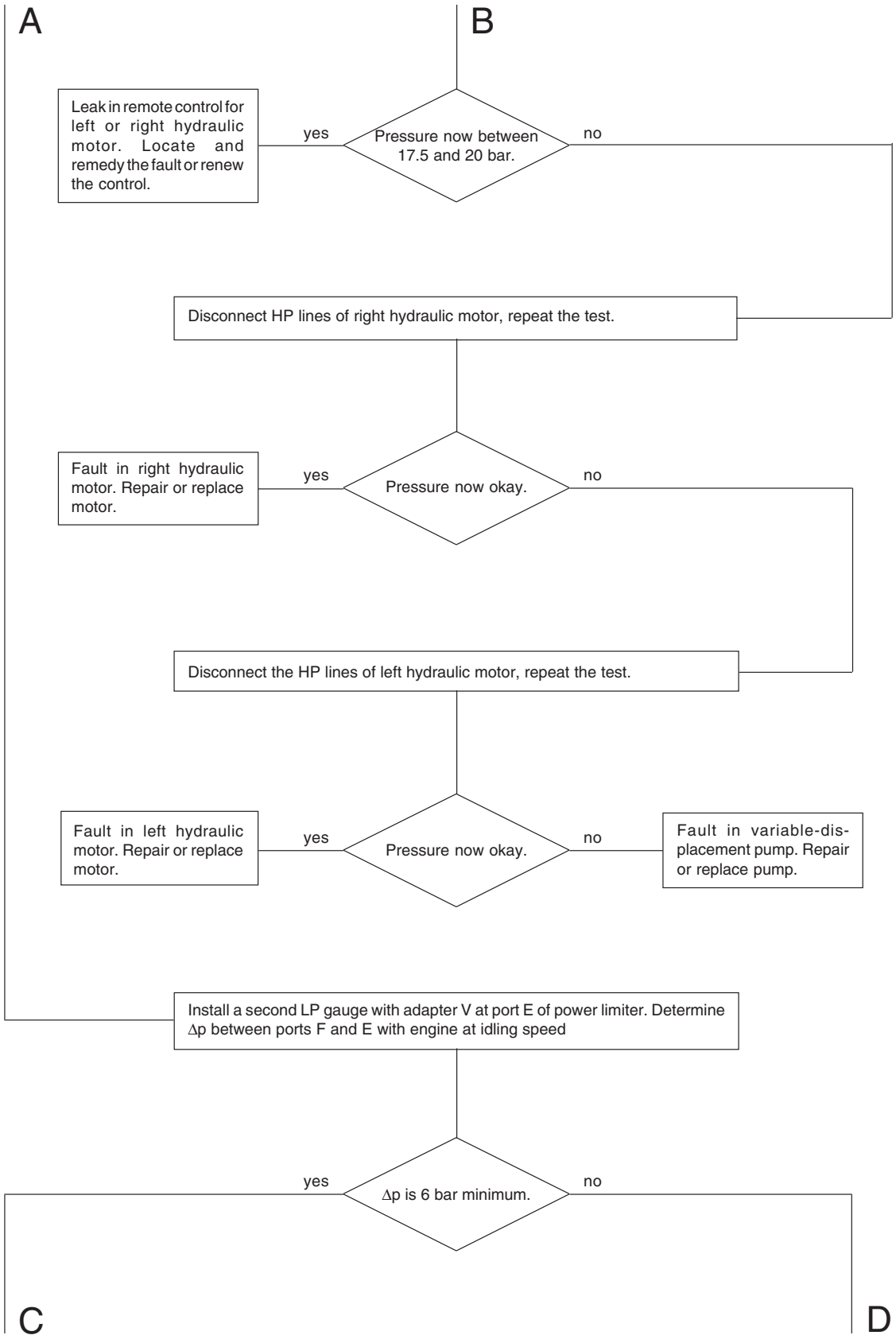

C
D
Set Δp to 11 +0.1 bar at valve (44) of travel control unit.
yes
Δp can be obtained.
no
Remove adapter III at ports YF and ZF and install LP gauge with adapter II to ports YF and ZF. With F and R accelerator pedals depressed to the stop, set Δp to 11 +0.1 bar.
Fault in hydraulic remote control. Repair or renew remote control.
yes
Δp obtained.
no
Fault in travel control unit. Repair or renew the unit.
Fully depress the F or R accelerator pedal. Measure the rotation of the left and right wheel and calculate the average wheel rpm.
In order.
yes
Average wheel speed 155 - 165 rpm
no
See "Hydrostatic travel drive".

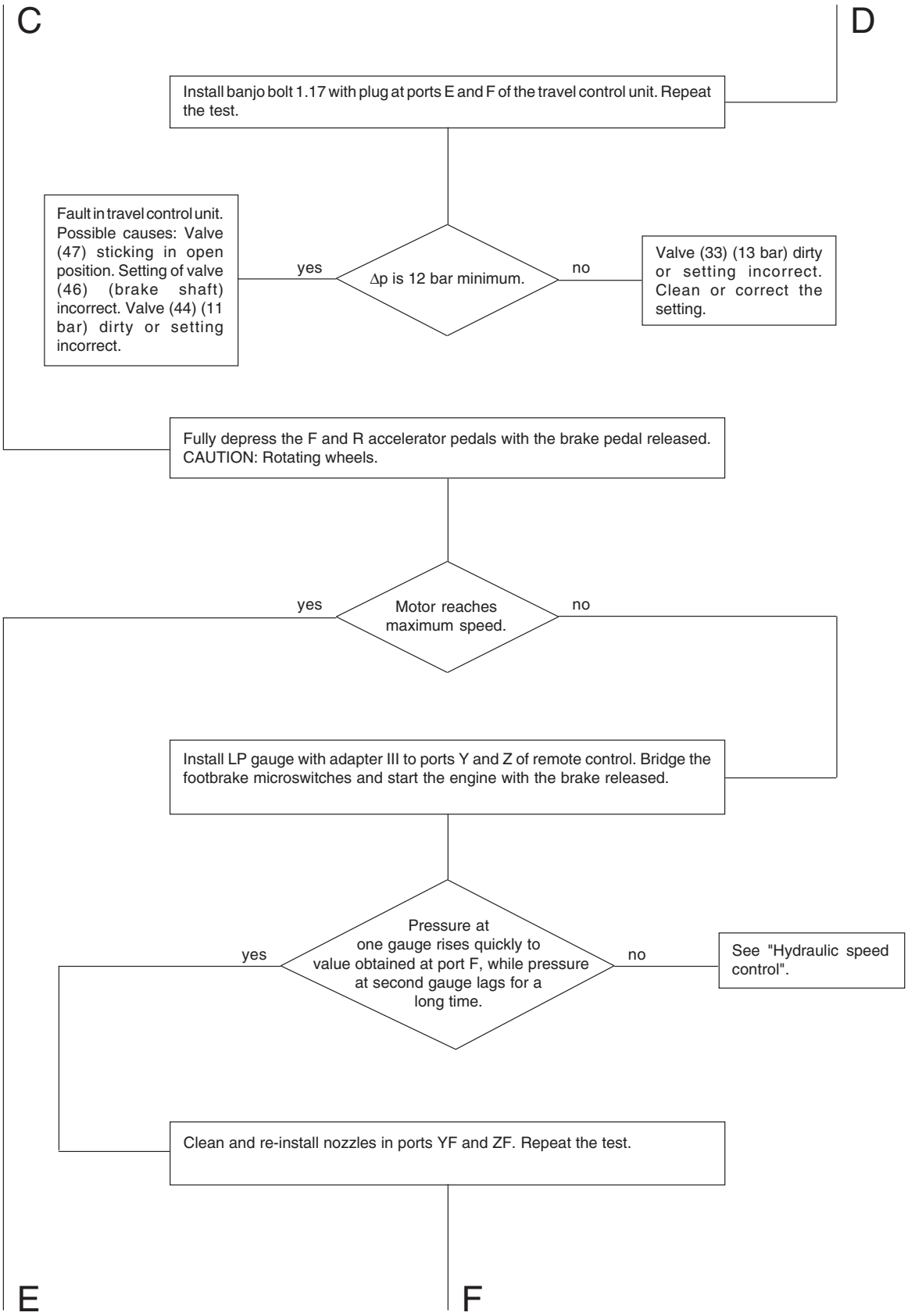
4.2.5.7 HYDROSTATIC TRAVEL DRIVE

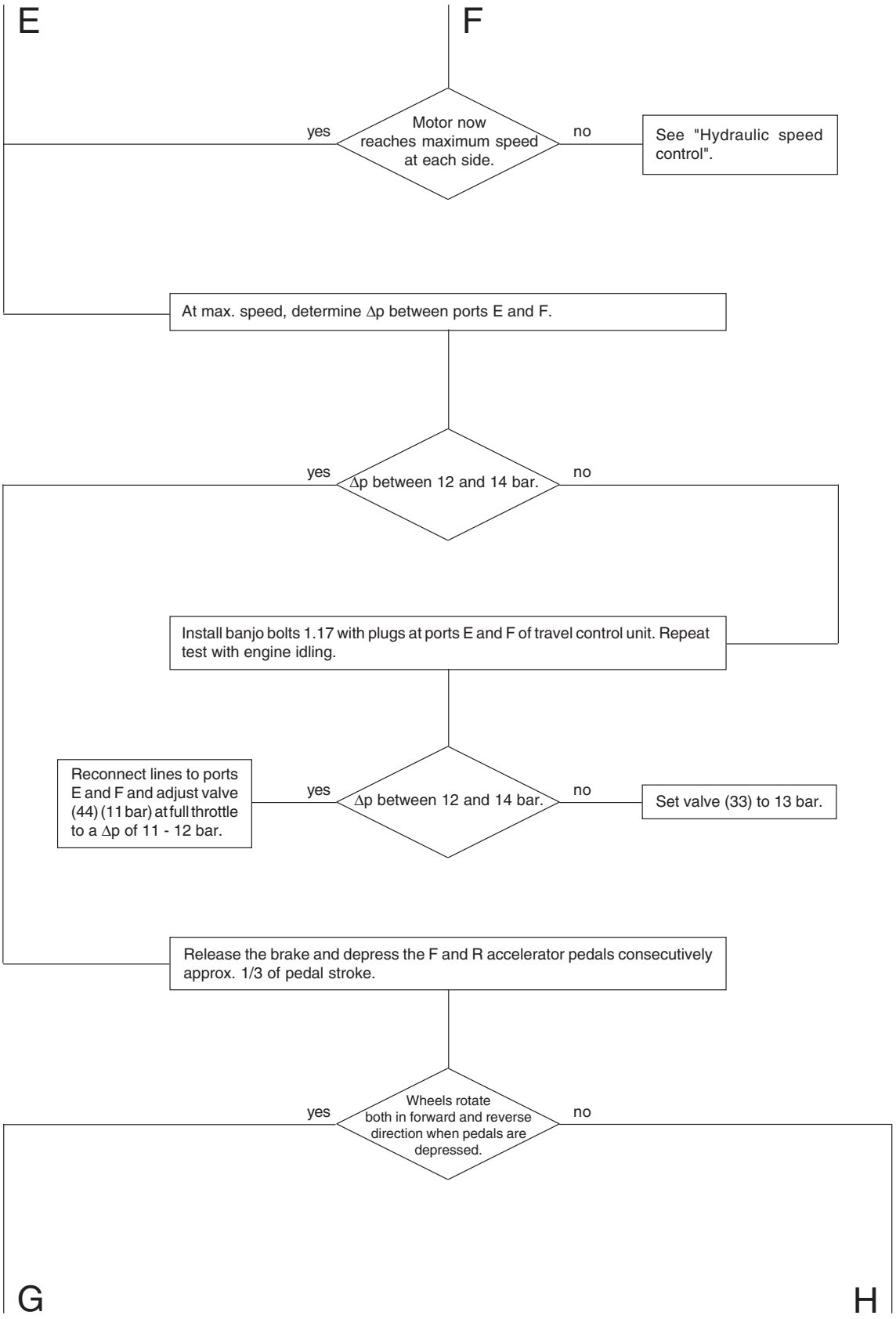
TEST CONDITIONS

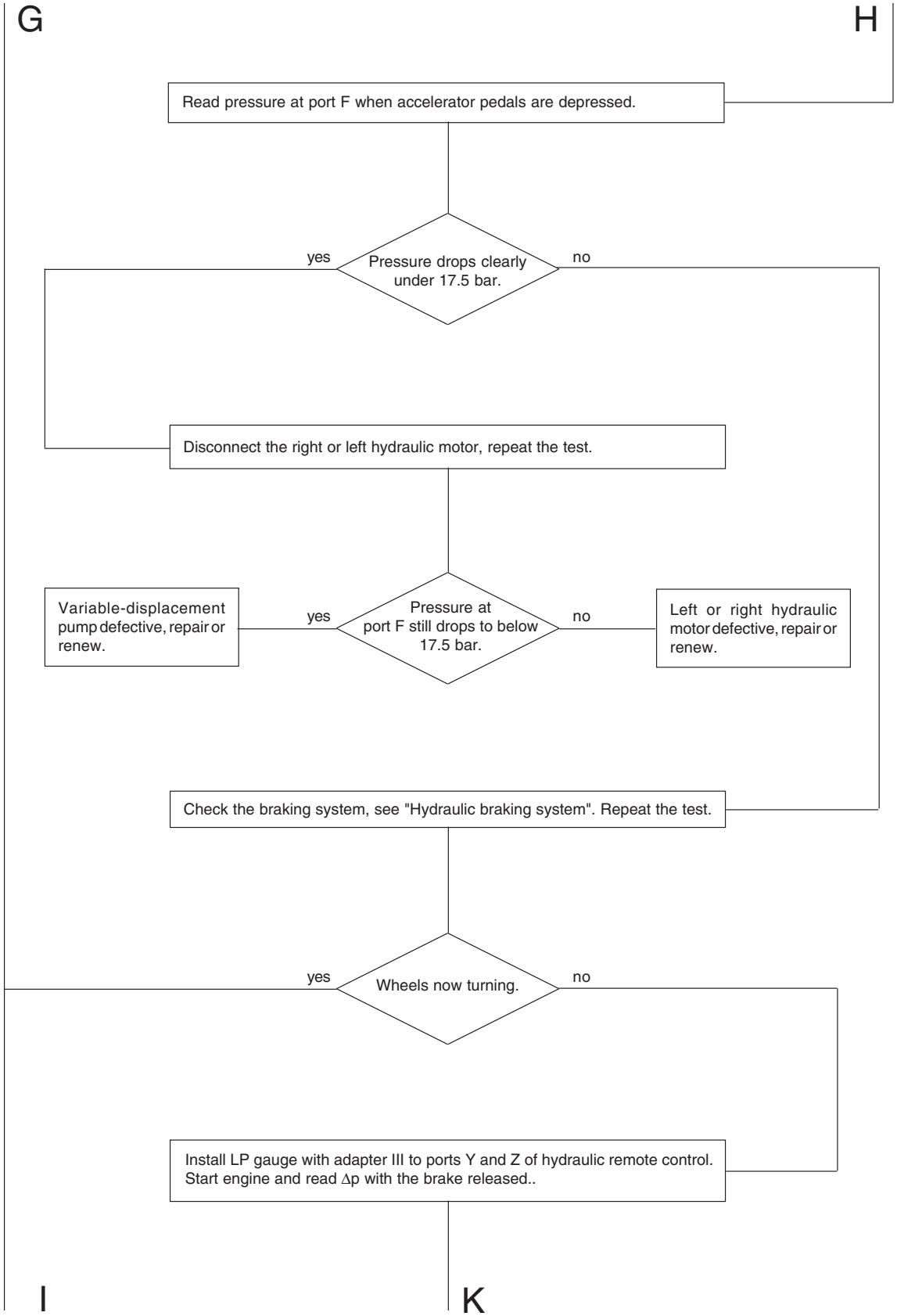
- Truck jacked up and secured so that both traction wheels can rotate freely.
- Hydraulic neutral in order.
- Engine cover raised.
- Floor plate removed.
- Pedals properly adjusted.
- Brake pedal locked in the "applied" position.
- Front cover removed.
- Engine and travel drive at operating temperature.

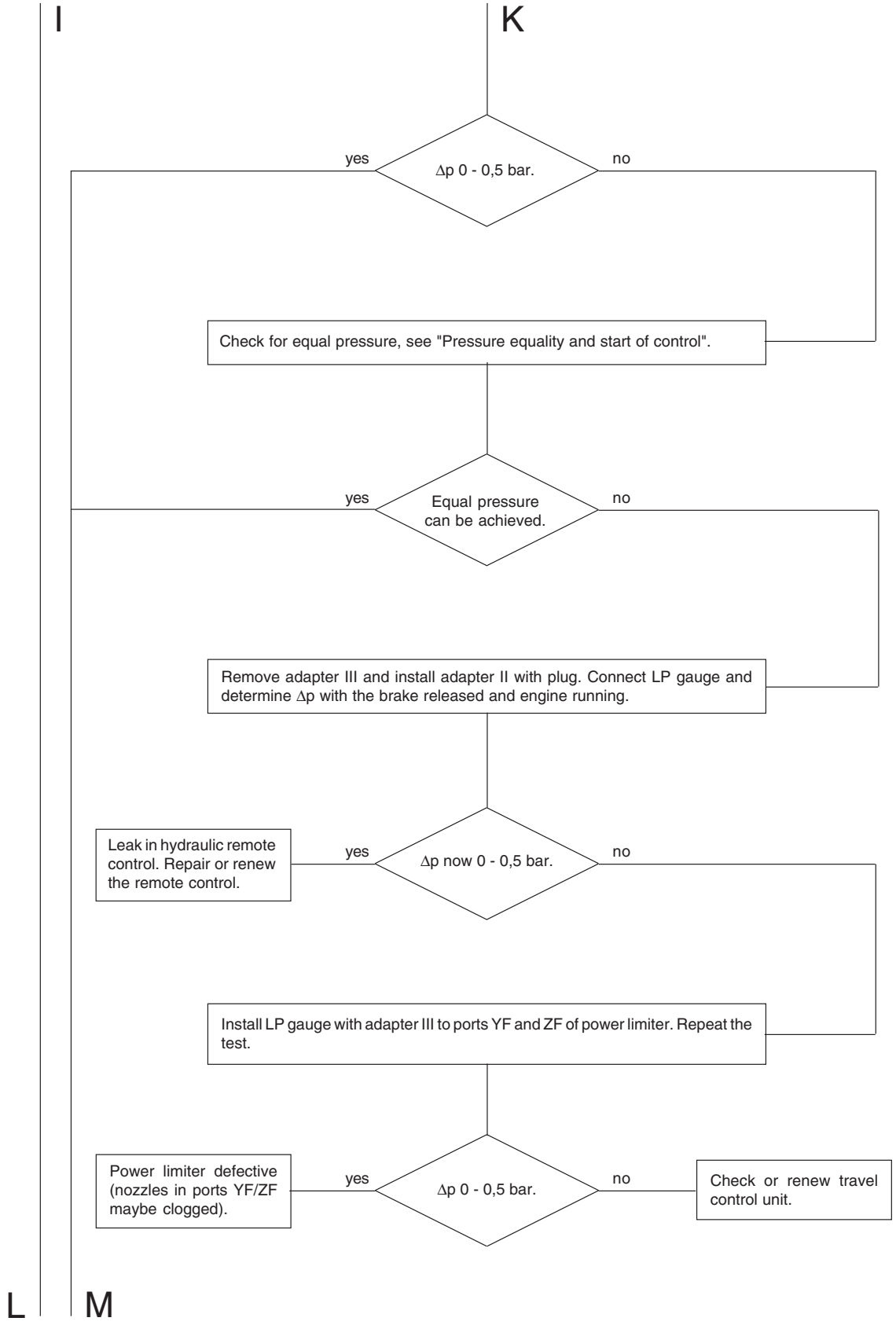

Install LP gauge with adapter V to port F of power limiter. Measure pressure with engine at idling speed and brake pedal released.
Pressure between 17.5 and 20 bar.
Pressure under 17.5 bar.
Pressure over 20 bar.
Check boost pressure valve (26) and increase spring tension, if necessary. Repeat the test.
Setting of boost pressure valve (26) too high. Adjust or renew the valve.
yes
Pressure now between 17.5 and 20 bar.
no
Disconnect the hydraulic lines at ports E and F of the power limiter and install LP gauge with adapter I directly to ports E and F. Determine the Δp between ports E and F at idling speed.
yes
Δp over 12 bar.
no
Boost pump (18) defective, replace pump.
Read pressure at port F.
A
B

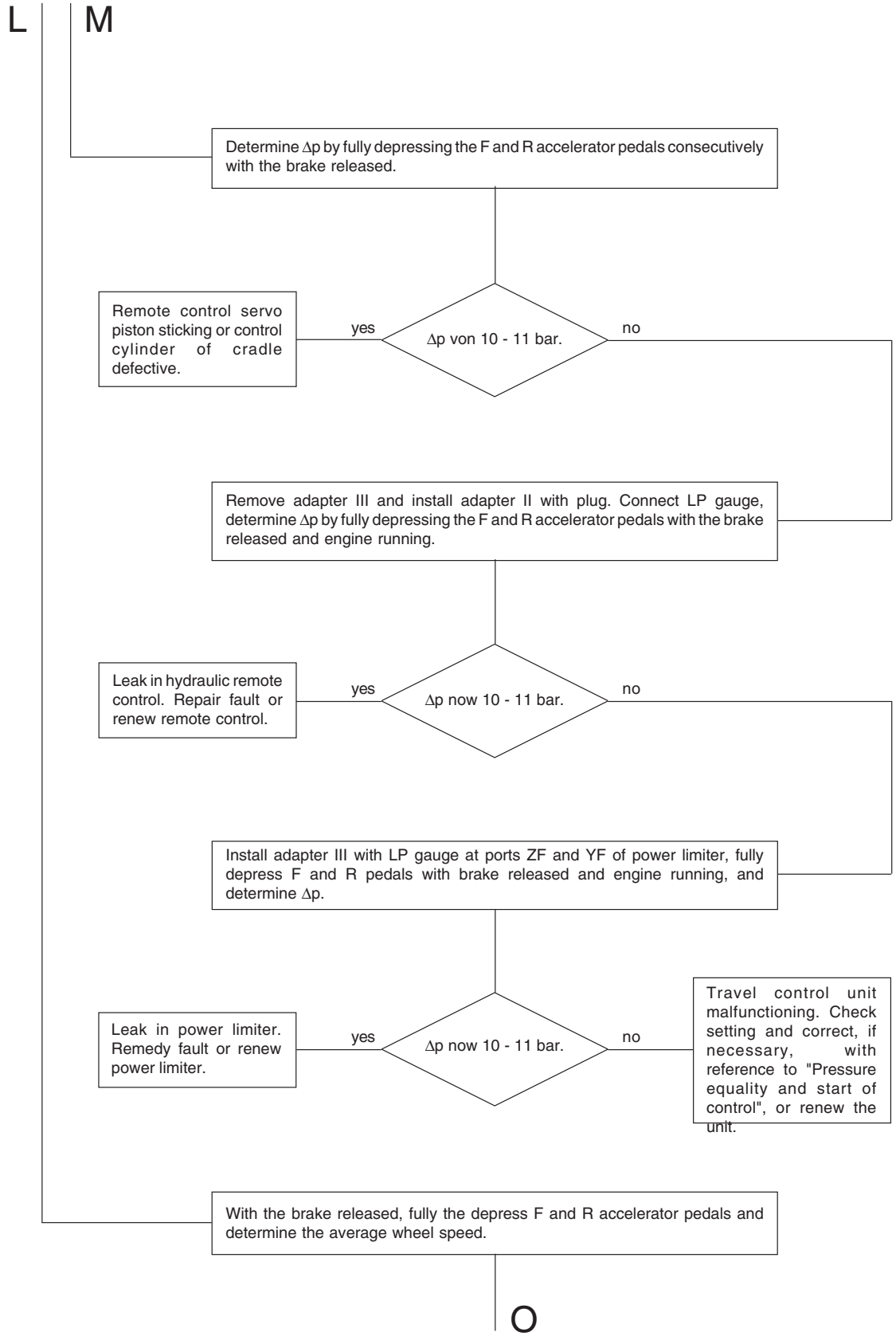

A
B
Leak in remote control for left or right hydraulic motor. Locate and remedy the fault or renew the control.
yes
Pressure now between 17.5 and 20 bar.
no
Disconnect HP lines of right hydraulic motor, repeat the test.
Fault in right hydraulic motor. Repair or replace motor.
yes
Pressure now okay.
no
Disconnect the HP lines of left hydraulic motor, repeat the test.
Fault in left hydraulic motor. Repair or replace motor.
yes
Pressure now okay.
no
Fault in variable-displacement pump. Repair or replace pump.
Install a second LP gauge with adapter V at port E of power limiter. Determine Δp between ports F and E with engine at idling speed
yes
Δp is 6 bar minimum.
no
C
D

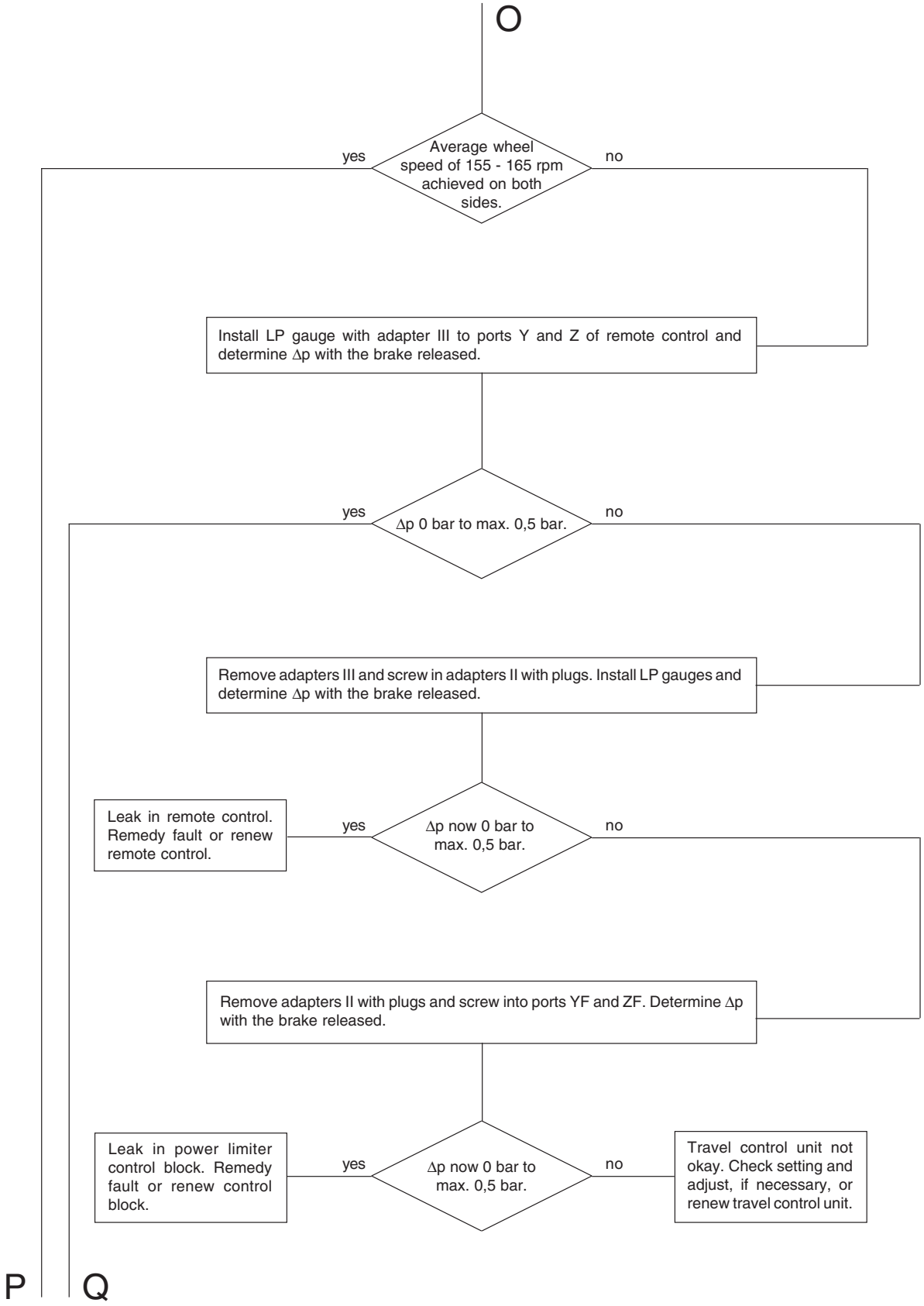

C
D
Install banjo bolt 1.17 with plug at ports E and F of the travel control unit. Repeat the test.
Fault in travel control unit. Possible causes: Valve (47) sticking in open position. Setting of valve (46) (brake shaft) incorrect. Valve (44) (11 bar) dirty or setting incorrect.
yes
Δp is 12 bar minimum.
no
Valve (33) (13 bar) dirty or setting incorrect. Clean or correct the setting.
Fully depress the F and R accelerator pedals with the brake pedal released. CAUTION: Rotating wheels.
yes
Motor reaches maximum speed.
no
Install LP gauge with adapter III to ports Y and Z of remote control. Bridge the footbrake microswitches and start the engine with the brake released.
yes
Pressure at one gauge rises quickly to value obtained at port F, while pressure at second gauge lags for a long time.
no
See "Hydraulic speed control".
Clean and re-install nozzles in ports YF and ZF. Repeat the test.
E
F


E
F
Motor now reaches maximum speed at each side.
yes
no
See "Hydraulic speed control".
At max. speed, determine Δp between ports E and F.
Δp between 12 and 14 bar.
yes
no
Install banjo bolts 1.17 with plugs at ports E and F of travel control unit. Repeat test with engine idling.
Reconnect lines to ports E and F and adjust valve (44) (11 bar) at full throttle to a Δp of 11 - 12 bar.
Δp between 12 and 14 bar.
yes
no
Set valve (33) to 13 bar.
Release the brake and depress the F and R accelerator pedals consecutively approx. 1/3 of pedal stroke.
Wheels rotate both in forward and reverse direction when pedals are depressed.
yes
no
G
H


G
H
Read pressure at port F when accelerator pedals are depressed.
yes
Pressure drops clearly under 17.5 bar.
no
Disconnect the right or left hydraulic motor, repeat the test.
Variable-displacement pump defective, repair or renew.
yes
Pressure at port F still drops to below 17.5 bar.
no
Left or right hydraulic motor defective, repair or renew.
Check the braking system, see "Hydraulic braking system". Repeat the test.
yes
Wheels now turning.
no
Install LP gauge with adapter III to ports Y and Z of hydraulic remote control. Start engine and read Δp with the brake released..
I
K


I
K
yes
Δp 0 - 0,5 bar.
no
Check for equal pressure, see "Pressure equality and start of control".
yes
Equal pressure can be achieved.
no
Remove adapter III and install adapter II with plug. Connect LP gauge and determine Δp with the brake released and engine running.
Leak in hydraulic remote control. Repair or renew the remote control.
yes
Δp now 0 - 0,5 bar.
no
Install LP gauge with adapter III to ports YF and ZF of power limiter. Repeat the test.
Power limiter defective (nozzles in ports YF/ZF maybe clogged).
yes
Δp 0 - 0,5 bar.
no
Check or renew travel control unit.
L
M


L
M
Determine Δp by fully depressing the F and R accelerator pedals consecutively with the brake released.
Remote control servo piston sticking or control cylinder of cradle defective.
yes
Δp von 10 - 11 bar.
no
Remove adapter III and install adapter II with plug. Connect LP gauge, determine Δp by fully depressing the F and R accelerator pedals with the brake released and engine running.
Leak in hydraulic remote control. Repair fault or renew remote control.
yes
Δp now 10 - 11 bar.
no
Install adapter III with LP gauge at ports ZF and YF of power limiter, fully depress F and R pedals with brake released and engine running, and determine Δp.
Leak in power limiter. Remedy fault or renew power limiter.
yes
Δp now 10 - 11 bar.
no
Travel control unit malfunctioning. Check setting and correct, if necessary, with reference to "Pressure equality and start of control", or renew the unit.
With the brake released, fully the depress F and R accelerator pedals and determine the average wheel speed.
O


O
Average wheel speed of 155 - 165 rpm achieved on both sides.
yes
no
Install LP gauge with adapter III to ports Y and Z of remote control and determine Δp with the brake released.
Δp 0 bar to max. 0,5 bar.
yes
no
Remove adapters III and screw in adapters II with plugs. Install LP gauges and determine Δp with the brake released.
Leak in remote control. Remedy fault or renew remote control.
Δp now 0 bar to max. 0,5 bar.
yes
no
Remove adapters II with plugs and screw into ports YF and ZF. Determine Δp with the brake released.
Leak in power limiter control block. Remedy fault or renew control block.
Δp now 0 bar to max. 0,5 bar.
yes
no
Travel control unit not okay. Check setting and adjust, if necessary, or renew travel control unit.
P
Q

P

Q

Fully depress the F and R accelerator pedals with the brake released and the engine running. Read Δp when pedals are fully depressed.

Δp of 11 - 11 bar obtained to both sides.

yes

no

Remove adapter III and screw in adapter II with plug. Determine Δp with the brake released and pedals fully depressed.

Δp of 10 - 11 bar now achieved.

yes

Leak in the remote control unit. Repair or renew the unit.

no

Remove adapter II with plug and install them at ports YF and ZF. Determine Δp with brake released and pedals fully depressed.

Δp now 10 - 11 bar.

yes

Leak in control block of power limiter, renew.

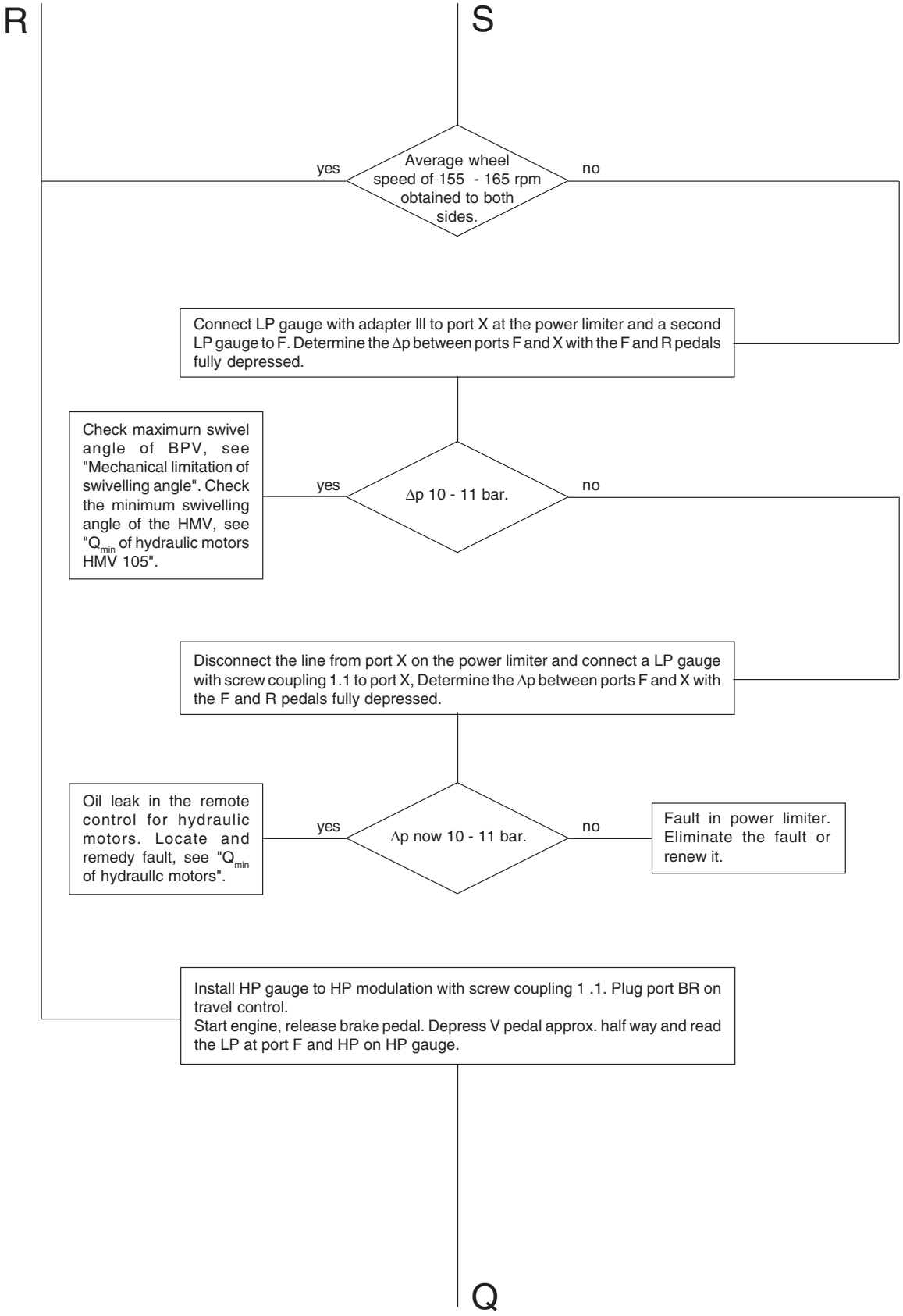
no

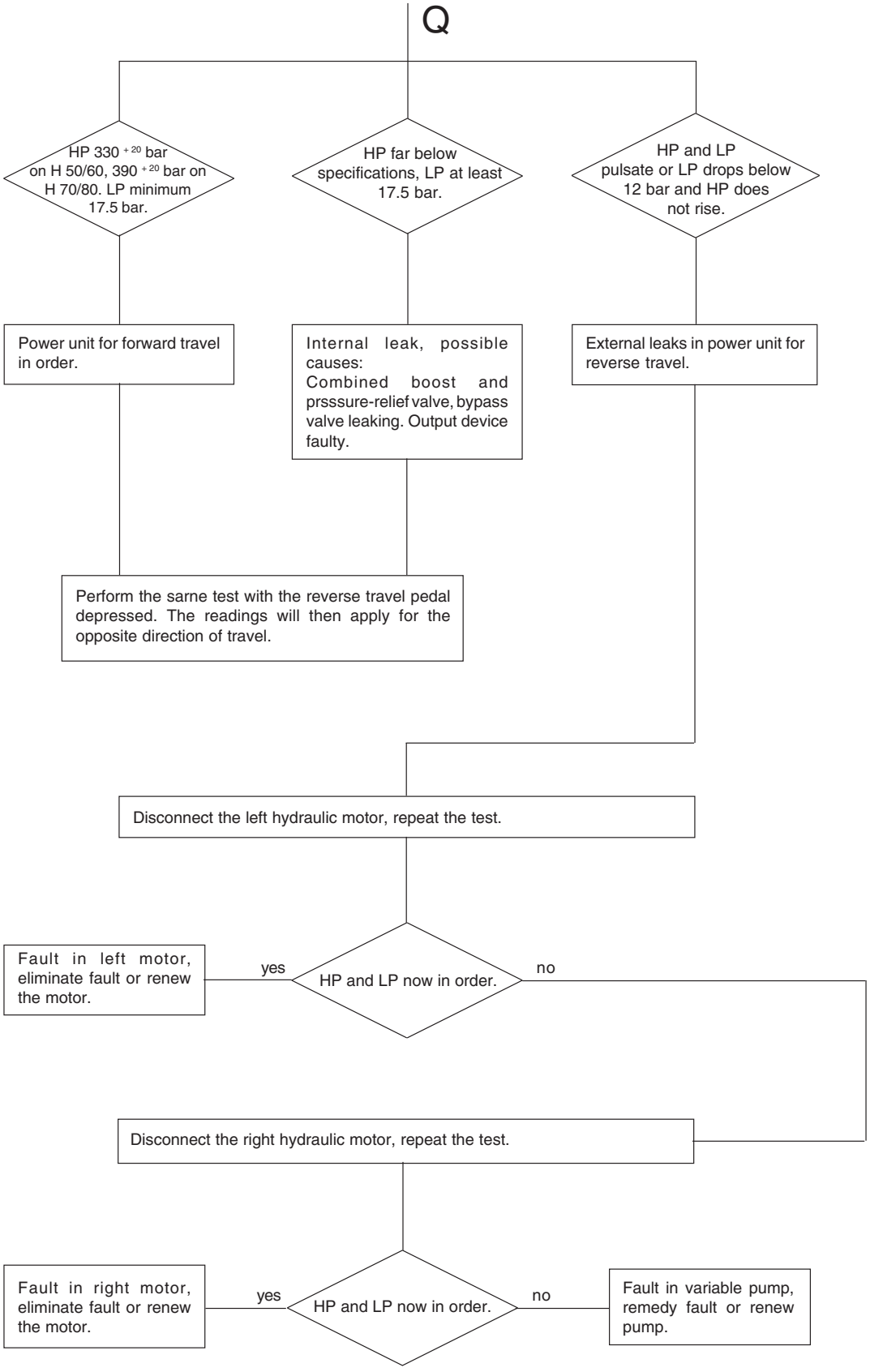
Travel control unit not okay. Check setting and adjust, if necessary, or renew the unit.

Fully depress the F and R accelerator pedals with the brake released and engine running. Determine the average wheel speed.

R

S


R
S
Average wheel speed of 155 - 165 rpm obtained to both sides.
yes
no
Connect LP gauge with adapter III to port X at the power limiter and a second LP gauge to F. Determine the Δp between ports F and X with the F and R pedals fully depressed.
Check maximurn swivel angle of BPV, see "Mechanical limitation of swivelling angle". Check the minimum swivelling angle of the HMV, see "Q min of hydraulic motors HMV 105".
Δp 10 - 11 bar.
yes
no
Disconnect the line from port X on the power limiter and connect a LP gauge with screw coupling 1.1 to port X, Determine the Δp between ports F and X with the F and R pedals fully depressed.
Oil leak in the remote control for hydraulic motors. Locate and remedy fault, see "Q min of hydraullc motors".
Δp now 10 - 11 bar.
yes
no
Fault in power limiter. Eliminate the fault or renew it.
Install HP gauge to HP modulation with screw coupling 1 .1. Plug port BR on travel control.
Start engine, release brake pedal. Depress V pedal approx. half way and read the LP at port F and HP on HP gauge.
Q


Q
HP 330 +20 bar on H 50/60, 390 +20 bar on H 70/80. LP minimum 17.5 bar.
HP far below specifications, LP at least 17.5 bar.
HP and LP pulsate or LP drops below 12 bar and HP does not rise.
Power unit for forward travel in order.
Internal leak, possible causes: Combined boost and prsssure-relief valve, bypass valve leaking. Output device faulty.
External leaks in power unit for reverse travel.
Perform the sarne test with the reverse travel pedal depressed. The readings will then apply for the opposite direction of travel.
Disconnect the left hydraulic motor, repeat the test.
Fault in left motor, eliminate fault or renew the motor.
yes
HP and LP now in order.
no
Disconnect the right hydraulic motor, repeat the test.
Fault in right motor, eliminate fault or renew the motor.
yes
HP and LP now in order.
no
Fault in variable pump, remedy fault or renew pump.

4.2.6 TEST AND ADJUSTMENT INSTRUCTIONS FOR HYDRAULIC PRIMARY AND SECONDARY CONTROL

The swash plate angle Q_{max} of the variable-displacement pump or the Q_{max}/Q_{min} of the hydraulic motors need only be checked if required in "Hydrostatic travel drive" of the troubleshooting.

The following tests and adjustments must only be performed by qualified skilled staff. The variable-displacement motors and pump can be destroyed if the adjustment instructions are not followed.

The following gauges and instruments are required:

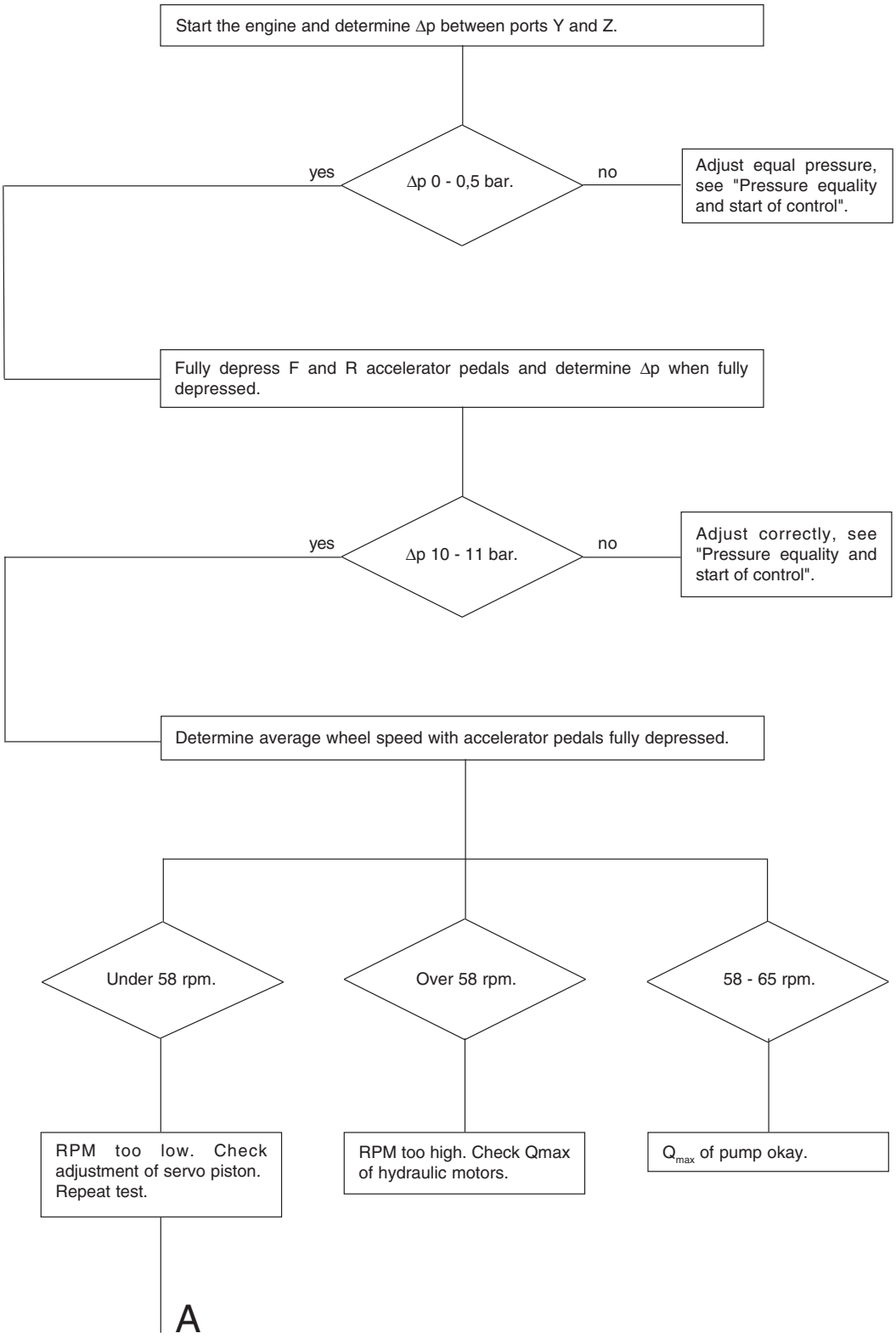
- hydraulic test box
- adapter No. 1.31 and 1.32
- tachometer for diesel engine
- tachometer for wheel speed

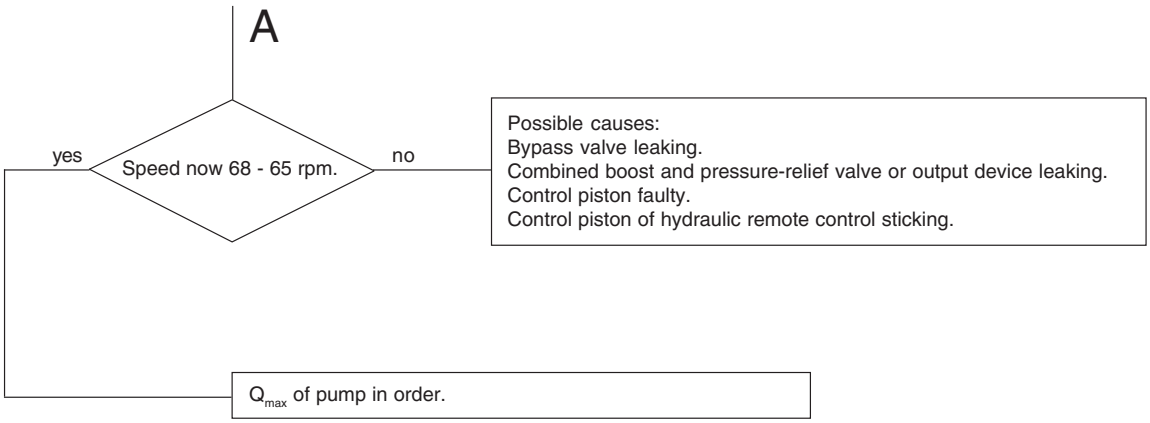
Test conditions for all the activities described below:

- Truck jacked up and secured so that the traction wheels can rotate freely.
- Floor plate removed.
- Traction motor and travel hydraulics at operating temperature.
- Engine speed reaches 2250 - 2350 rpm when the brake is released and the accelerator pedals are fully depressed.
- Screw in adapter III at ports Y and Z of the remote control unit and install a LP gauge.
- Install round connector 1.31 and banjo bolt 1.32 at port X of the power limiter between the valve block and piping and close the valve on banjo bolt 1.32.

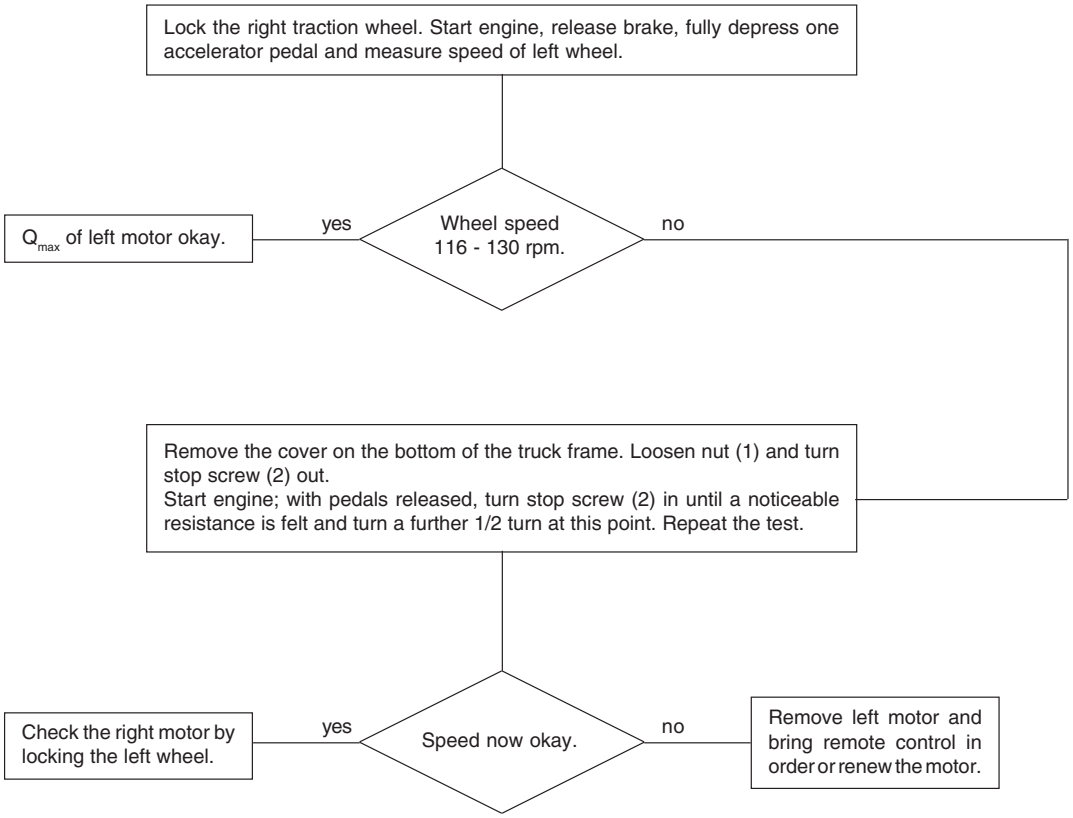
NOTE: A new seal 000 962 0437 must be used each time between round connector 1.31 and the pipe.

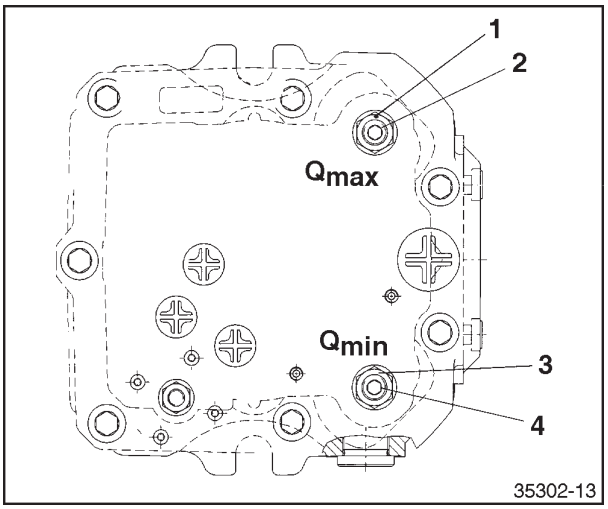
4.2.6.1 Q_{MAX} OF VARIABLE DISPLACEMENT PUMP BPV 100


Start the engine and determine Δp between ports Y and Z.
Δp 0 - 0,5 bar.
yes
no
Adjust equal pressure, see "Pressure equality and start of control".
Fully depress F and R accelerator pedals and determine Δp when fully depressed.
Δp 10 - 11 bar.
yes
no
Adjust correctly, see "Pressure equality and start of control".
Determine average wheel speed with accelerator pedals fully depressed.
Under 58 rpm.
Over 58 rpm.
58 - 65 rpm.
RPM too low. Check adjustment of servo piston. Repeat test.
RPM too high. Check Qmax of hydraulic motors.
Qmax of pump okay.
A


A
yes
Speed now 68 - 65 rpm.
no
Possible causes:
Bypass valve leaking.
Combined boost and pressure-relief valve or output device leaking.
Control piston faulty.
Control piston of hydraulic remote control sticking.
Q_{max} of pump in order.

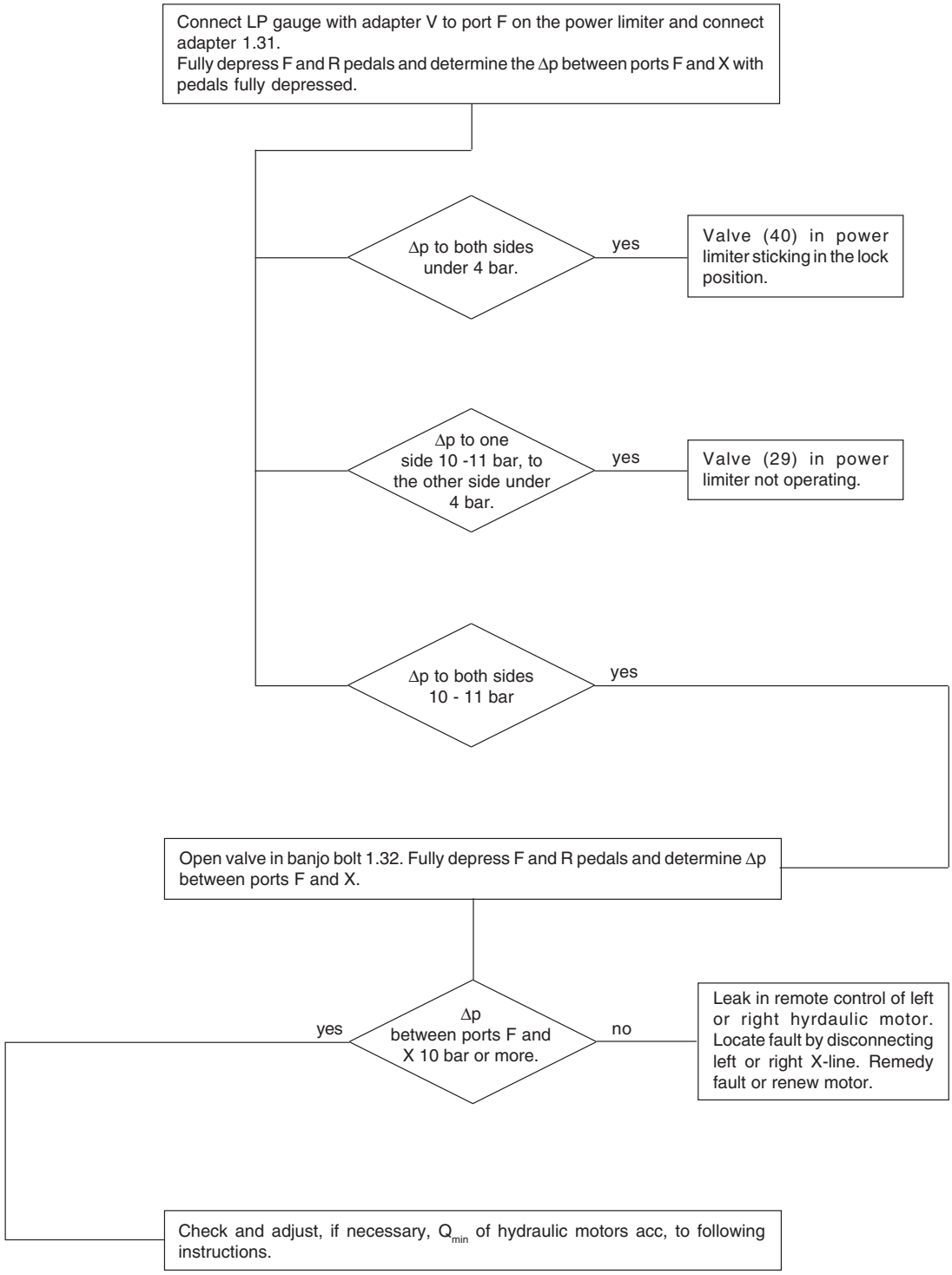
4.2.6.2 Q_{MAX} OF HYDRAULIC MOTORS HMV 105


Lock the right traction wheel. Start engine, release brake, fully depress one accelerator pedal and measure speed of left wheel.
Wheel speed 116 - 130 rpm.
yes
Q_{max} of left motor okay.
no
Remove the cover on the bottom of the truck frame. Loosen nut (1) and turn stop screw (2) out.
Start engine; with pedals released, turn stop screw (2) in until a noticeable resistance is felt and turn a further 1/2 turn at this point. Repeat the test.
Speed now okay.
yes
Check the right motor by locking the left wheel.
no
Remove left motor and bring remote control in order or renew the motor.



4.2.6.3 Q_{MIN} OF HYDRAULIC MOTORS HMV 105

Condition: Q_{max} of variable displacement pump and the hydraulic motors is in order.


Connect LP gauge with adapter V to port F on the power limiter and connect adapter 1.31.
Fully depress F and R pedals and determine the Δp between ports F and X with pedals fully depressed.
Δp to both sides under 4 bar.
yes
Valve (40) in power limiter sticking in the lock position.
Δp to one side 10 -11 bar, to the other side under 4 bar.
yes
Valve (29) in power limiter not operating.
Δp to both sides 10 - 11 bar
yes
Open valve in banjo bolt 1.32. Fully depress F and R pedals and determine Δp between ports F and X.
Δp between ports F and X 10 bar or more.
yes
no
Leak in remote control of left or right hyrdaulic motor. Locate fault by disconnecting left or right X-line. Remedy fault or renew motor.
Check and adjust, if necessary, Q_{min} of hydraulic motors acc, to following instructions.

CHECKING Q_{MIN}

- Shut off the engine, lock the left wheel, close the valve on 1.32 and put a 5-mm spacer between injection pump lever and stop screw for maximum engine speed.

- Start the engine, fully depress an accelerator pedal (engine speed reaches approx. 1200 rpm) and measure the speed of the right wheel.

- Now open the valve on 1.32 and measure the wheel speed again (hydraulic motor now goes from Q_{max} to Q_{min}). When the valve is open, the wheel speed must be higher by a factor of 2.62 than when the valve is closed.

Example:

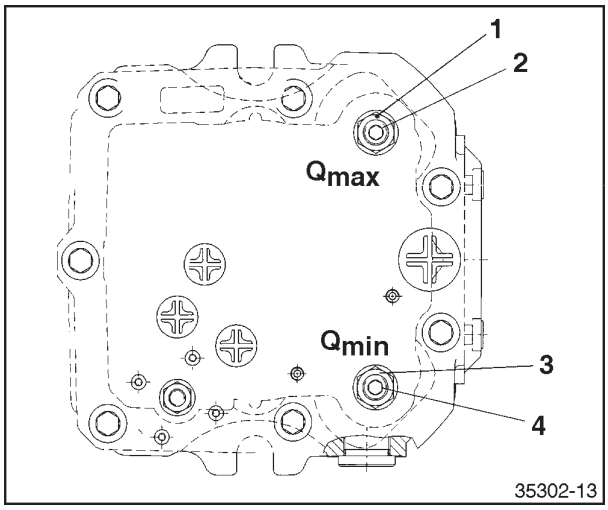
Wheel speed with valve close	x factor	=	Required speed at Q_{min} with valve open
60 rpm	x 2,62	=	157 rpm

The required speed can be adjusted with the stop screw (4).
Tolerance range + 0 / - 10 rpm.
Turning screw in = decreases rpm
Turning screw out = increases rpm

In the secondary control the engine speed is a little lower, depending on the operating temperature of the engine and the travel drive. For this reason the wheel speed will be near the lower tolerance limit.

- Perform the same test with the right wheel locked.

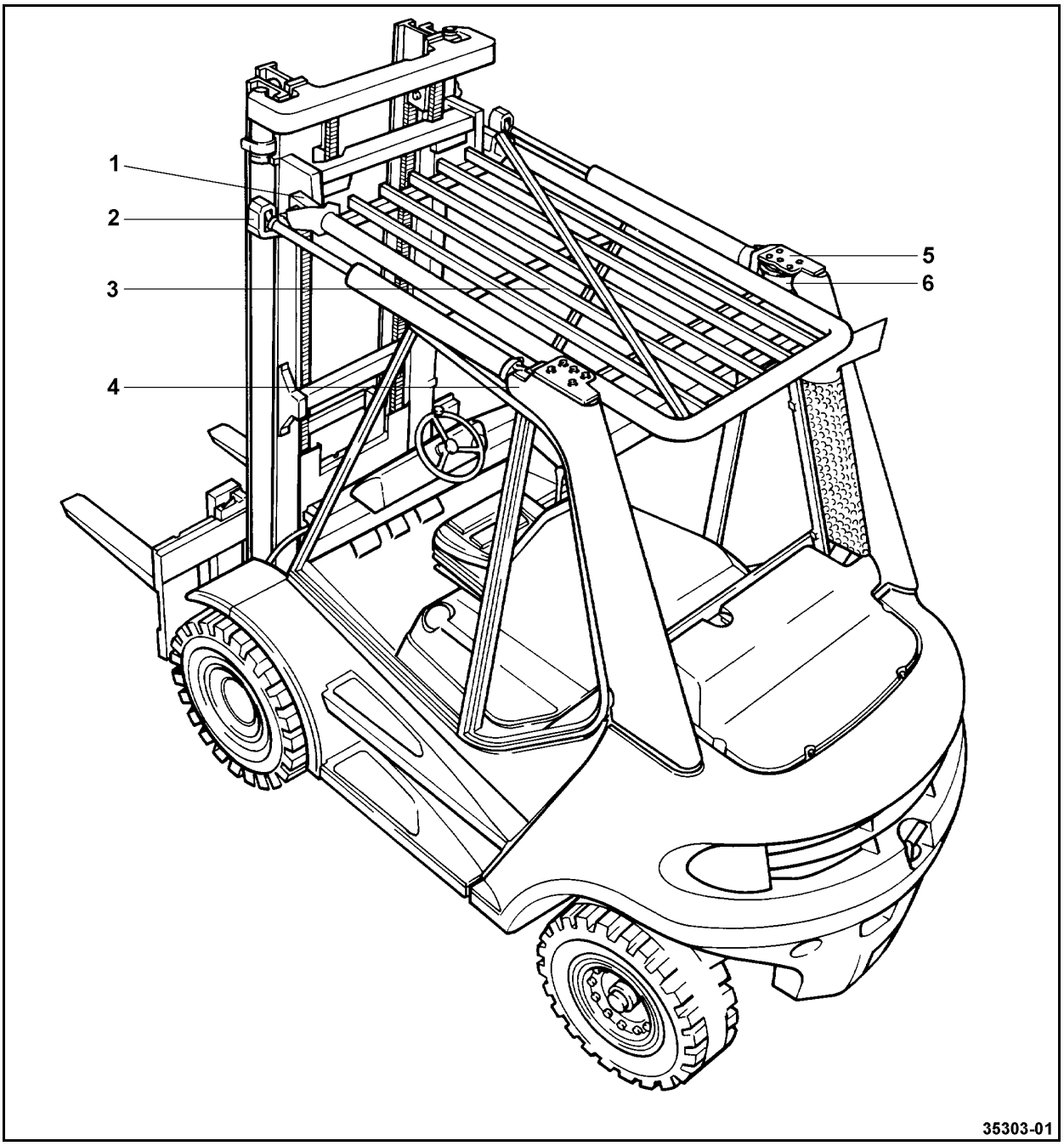
- After checking the primary and secondary control, make the truck operational again and trial drive the truck.



4.3 CHASSIS

4.3.1 OVERHEAD GUARD - TORSION MOUNTING

The overhead guard is fastened to a cross member at the top of the mast so that it follows the mast when tilted. At the rear supports, the overhead guard is guided in two adjustable rollers. This type of roof construction increases the torsion stiffness of the mast and it is called a torsion mounting.



1 Overhead guard pivot articulation on the mast
2 Front mounting of tilt cylinders
3 Overhead guard
4 Rear mounting of tilt cylinders
5 Roller mount
6 Overhead guard guide roller

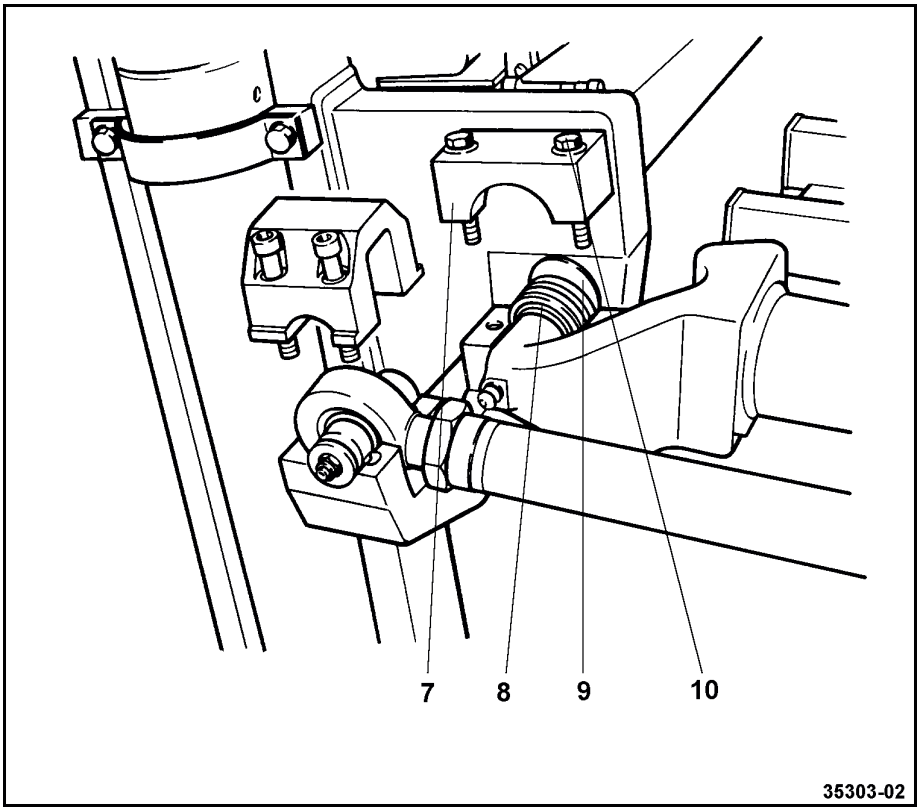
4.3.1.1 WORK ON THE OVERHEAD GUARD

DISASSEMBLY

- Slacken the fastening screws on the left and right roller mounts (5) and slide the mount outward in the area of the bearing holes.
- Dismantle the left and right bearing bracket (7).
- Take off the overhead guard by lifting it up.

ASSEMBLY

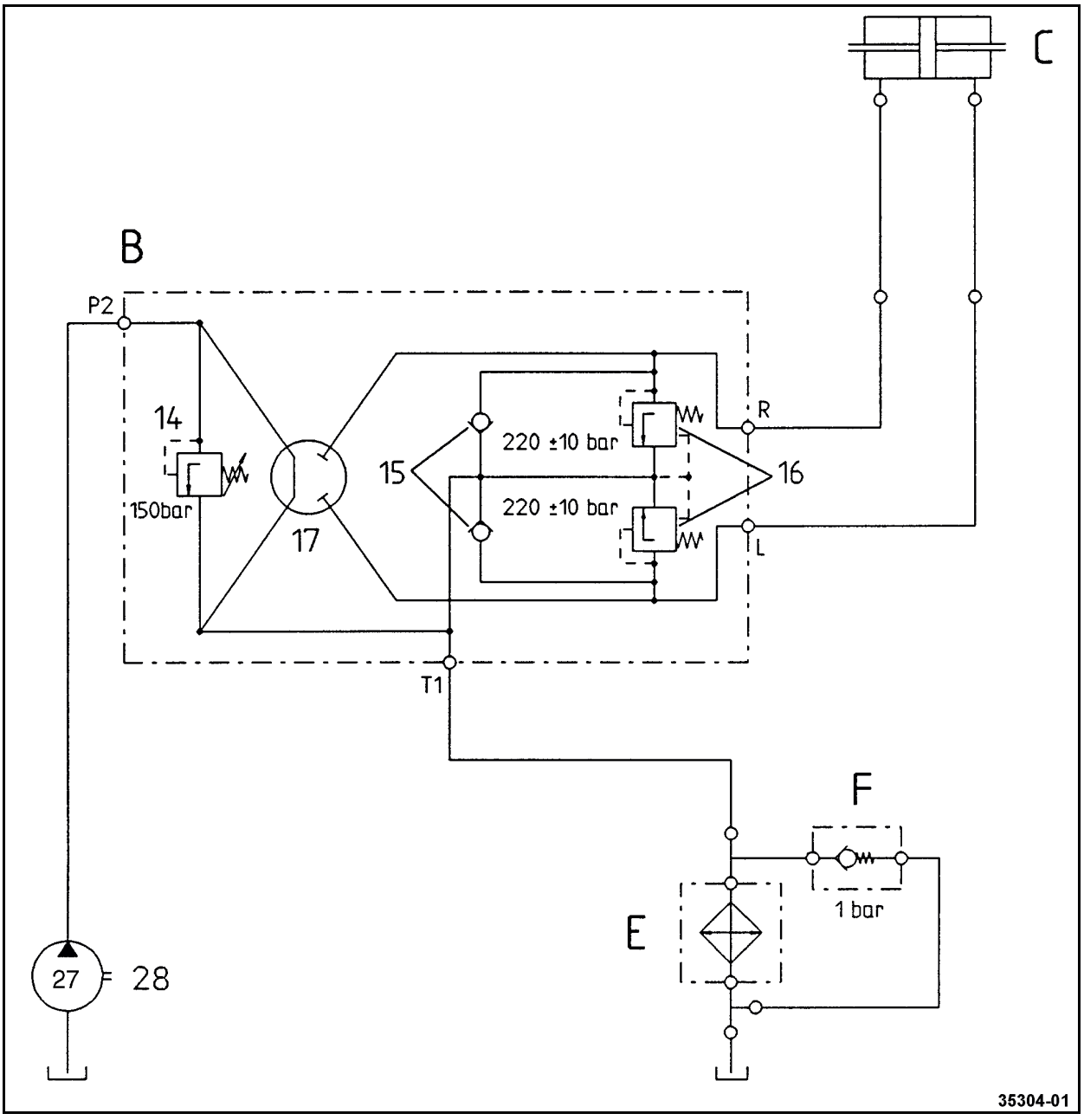
- Place the overhead guard along with the mounted bearings (8) into the outer mast mounting.



- Remove any lateral play in the overhead guard with shims (9).
- Install the bearing brackets (7) and torque the screws (10) to 80 Nm.
- Using a mounting iron, position the left and right roller mounts (4) without play on the overhead guard tube sections and handtighten the mount fastening screws.
- Start the engine and tilt the mast forward and backward. This will adjust the rollers at the widest section of the overhead guard practically without any play.
- Torque the roller mount fastening screws to 80 Nm.

4.4 STEERING SYSTEM

4.4.1 POWER STEERING CIRCUIT DIAGRAM



B Steering control valve assy. consisting of:

14 Pressure-relief valve
15 Make-up valve
16 Shock valve
17 Steering control valve

C Steering cylinder

E Oil cooler

F Cooler bypass valve, 1 bar

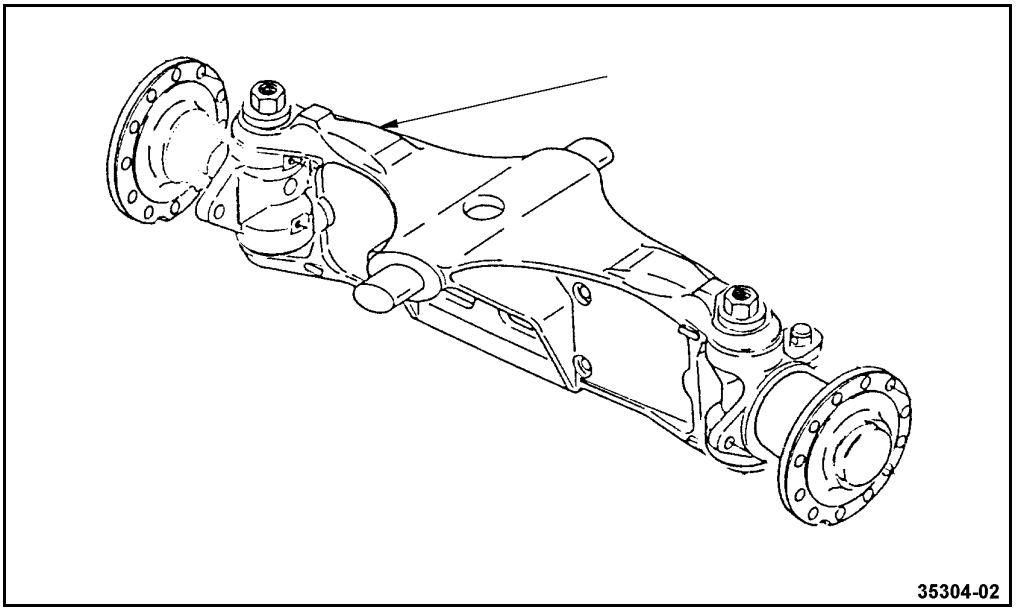
28 Gear pump, 27 cc/rev

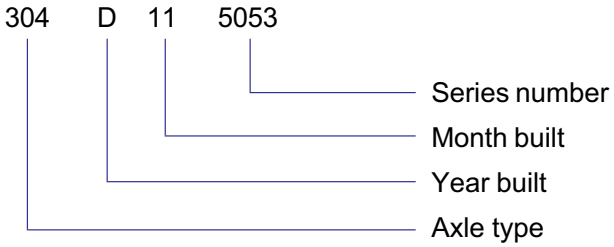
OPERATION OF THE POWER STEERING

The oil from the pump (28) enters the steering control valve (B) at port P2, flows through the steering control valve (17), leaves the valve through port T1 and goes back to the tank through the oil cooler (E).
Turning the steering wheel closes the P2-T2 connection and the oil coming from P2 is fed to the steering cylinder via port R or L. The maximum pressure on the primary side is set to 150 bar.
When the steering wheel is not operated, the secondary valves (16) limit the restoring force and the peak pressures connected therewith to 220 bar.
The make-up valves (15) ensure that the steering can be operated in an emergency.

4.4.2 SERIES 304 STEERING AXLE

EXPLANATION OF THE STEERING AXLE SERIES NUMBER



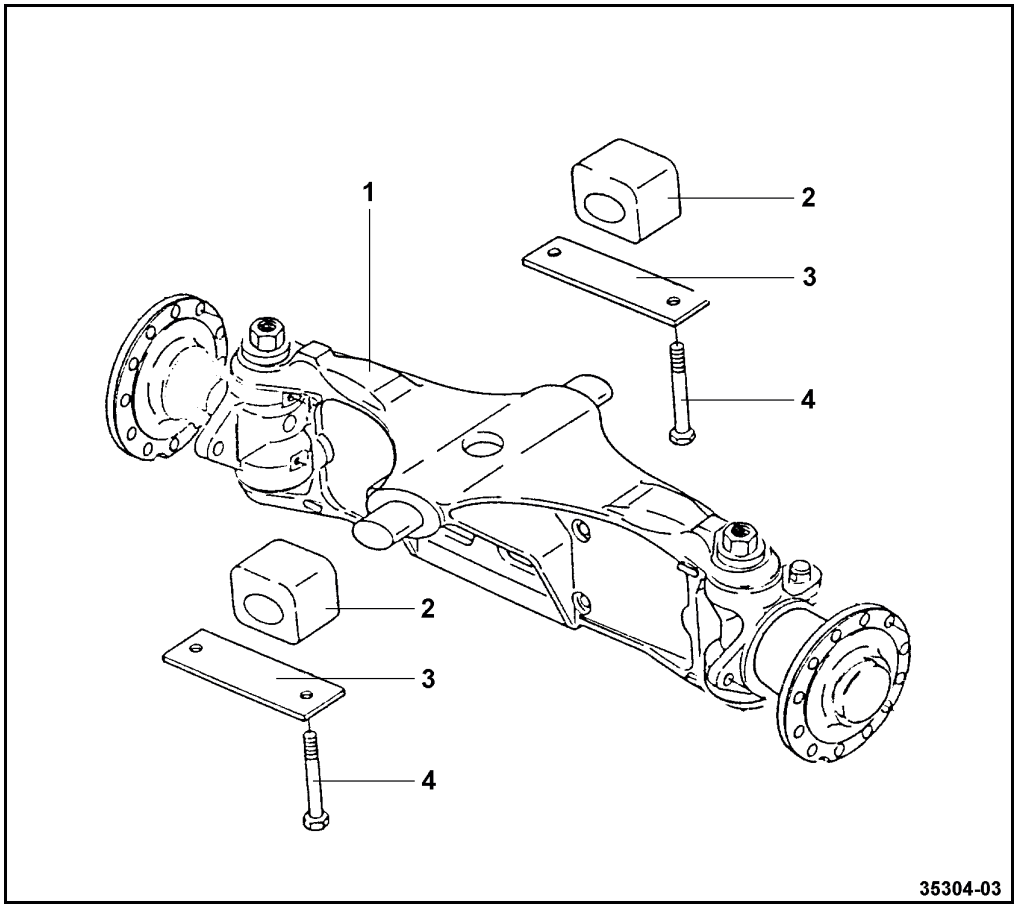


4.4.2.1 DESCRIPTION

The rear wheels are steered by means of a double-acting hydraulic cylinder mounted to the steering cylinder and the two steering knuckles with two track rod links (fixed length). The motion of the steering wheel activates the steering control valve controlling the oil flow to the steering cylinder.
The axle body is mounted to the frame with shock mounts allowing the axle to swing on uneven ground.
The steering cylinder is mounted on the axle body with dowel pins and four bolts.
The track rod links have covered joint bearings on both ends and they are joined to the piston rod and steering knuckle with press-in pins and roll pins.
These connecting rods have a fixed length so that the wheel alignment does not have to be adjusted.

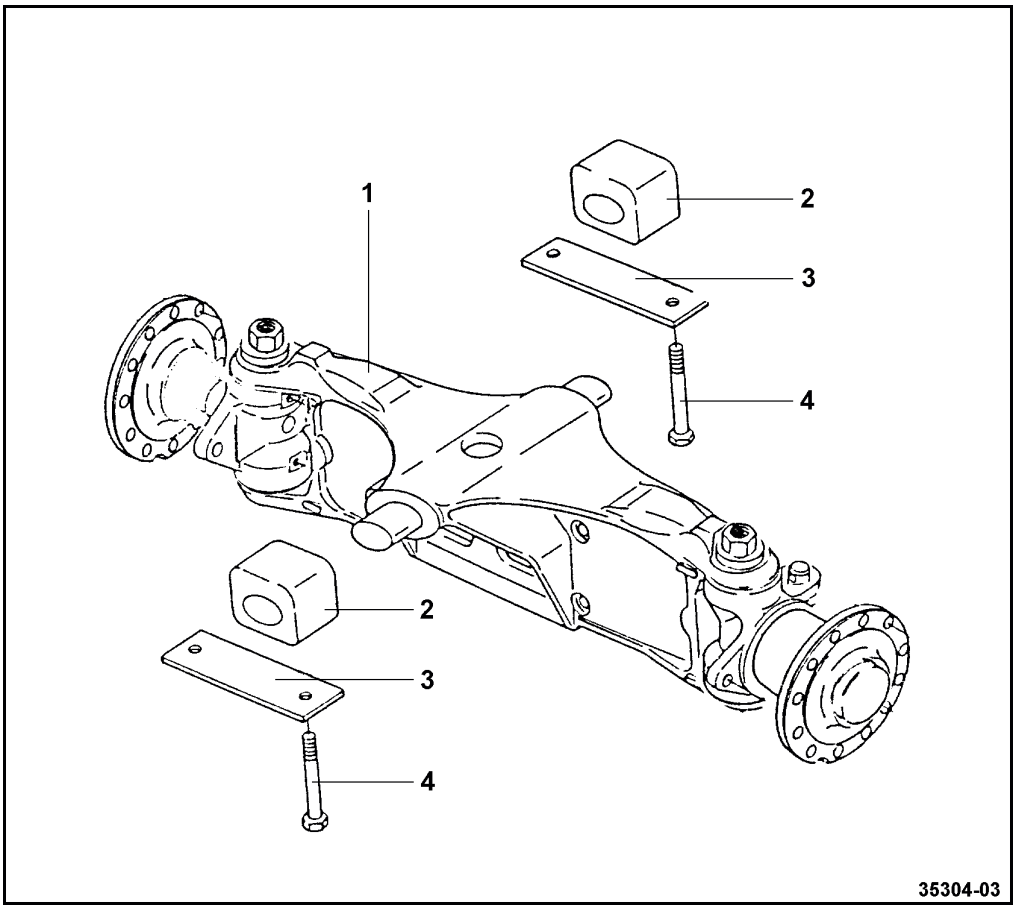
4.4.3 STEERING AXLE REMOVAL

- Remove the wheel mounting screws on both wheels.
- Jack up and securely block the rear of the truck.
- Remove the rear wheels.
- Support the steering axle (1).
- Remove the mounting screws (4).
- Remove the plate (3).
- Slowly lower the steering axle (1) with the axle block (2).
- Place an oil pan underneath.
- Disconnect the tubes on both sides of the steering cylinder.



4.4.3.1 STEERING AXLE INSTALLATION

- Mount the two axle blocks (2) on the centre of the axle.
  NOTE: Axle blocks are not symmetrical, wide section must be shown up!
- Place the steering axle (1) into the counterweight from below. Raise the steering slightly until the two axle blocks (2) contact the counterweight and underpin it.
- Coat the mounting screws (4) with Loctite 270.
- Fasten the two plates (3) and axle blocks (2) with screws (4).
- Torque the screws (4) to 395 Nm (39.5 mkp).
- Connect the tubes on both sides of the steering cylinder.
- Eliminate any air in the steering by turning the steering wheel through its full travel cycle about 10 times.
- Mount the wheels.
- Lower the truck.
- Tighten opposite wheel mounting screws to a torque of 650 Nm.



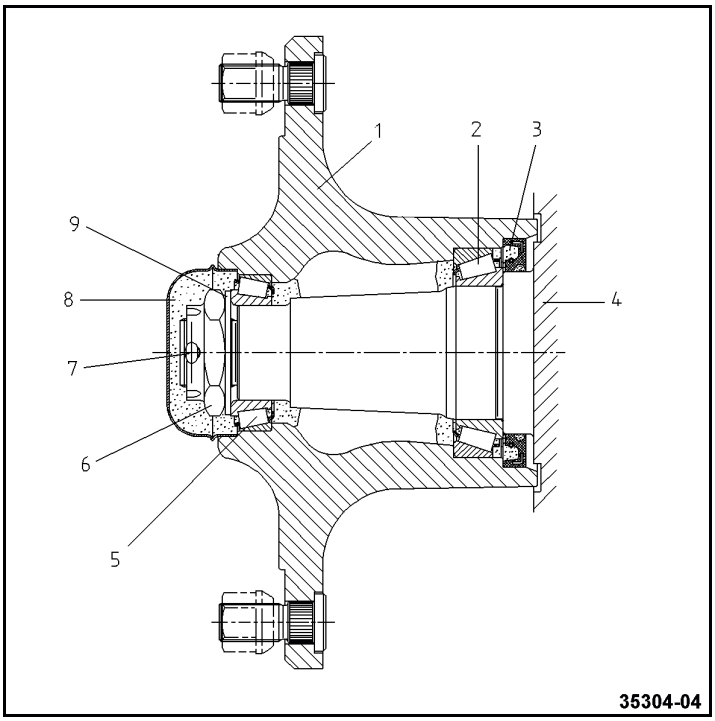
4.4.4 STEERING AXLE REPAIRS

NOTE: The following services can be performed without removing the steering axle from the truck.

4.4.4.1 RENEWING THE WHEEL BEARINGS

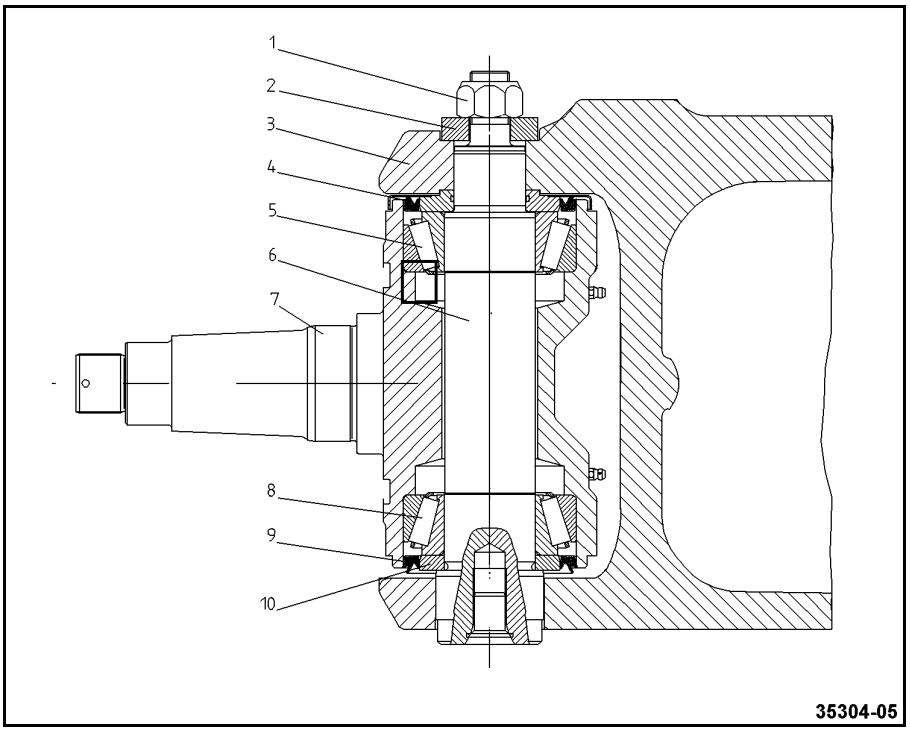
- Jack up the truck.
- Remove the wheel.
- Remove the cap (8).
- Drive out the cotter pin (7).
- Loosen and remove the 55 mm nut (6).
- Drive out the wheel hub (1) out from the inside with a plastic hammer.
- Renew the outer bearing ring of taper roller bearings (2) and (5) and also the shaft seal (3).
- Pull the taper roller bearing (2) from the knuckle (4) and renew it.
- Fill the wheel bearing chambers around the taper roller bearing with grease (as illustrated).
- Position the wheel hub on the knuckle and drive on the bearing (5). Put the thrust washer (9) in place, fit the screw (6) and tighten it to 150 Nm.
- Turn the screw back to the nearest cotter pin hole and secure with a cotter pin.
- Fill the cap (8) with lithium-based grease (Part No. 733 740 0160), place it on the wheel hub and secure by tapping it with a plastic hammer.

WHEEL HUB



1 Wheel hub
2 Inner taper roller bearing
3 Shaft seal
4 Knuckle
5 Outer taper roller bearing
6 Crown nut
7 Cotter pin
8 Cap
9 Thrust washer

4.4.4.2 STEERING KNUCKLE REMOVAL AND INSTALLATION

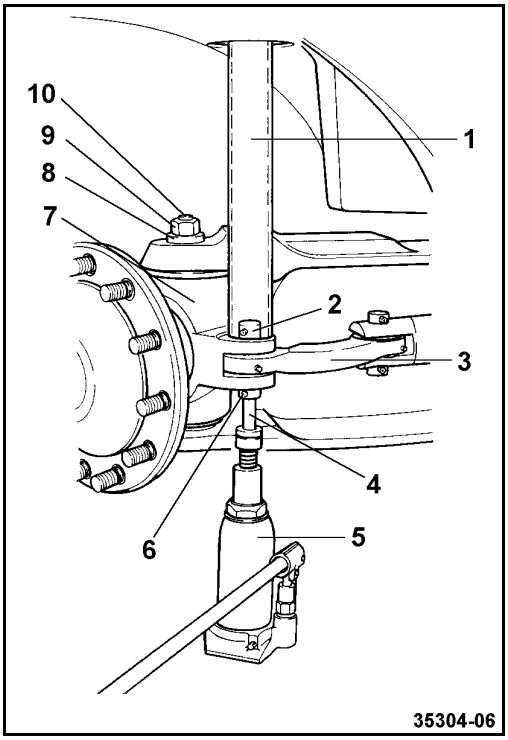


1 Nut
2 Thrust washer
3 Knuckle body
4 Seal
5 Taper roller bearing
6 King pin
7 Knuckle
8 Taper roller bearing
9 Seal
10 Spacer

STEERING KNUCKLE REMOVAL

- Jack up the truck.
- Remove the wheels.
- Turn the steering until the pin (2) retaining the track rod (3) is positioned in the counterweight recess.
- Drive out the roll pins (6).
- Place the special tool (4) on the jack (5) and position it under the pin (2).
- Support the knuckle (7) against the counterweight with a pipe (1).
- Operate the jack (7) and press out the pin (2).
- Secure the steering axle from swinging by putting wooden wedges between the axle body and counterweight.
- Loosen the nut (9) and remove it along with the washer (8).
- Position the jack (5) over the king pin (10) and support it against the counterweight. Now press pin (10) out with the jack (5).

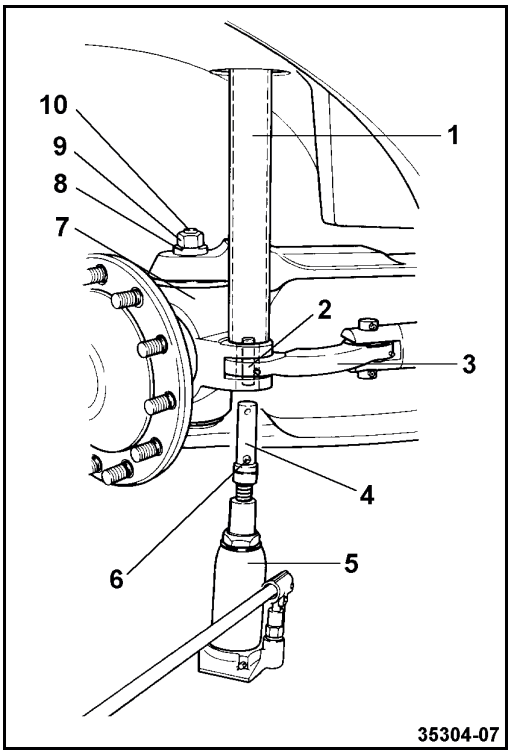
  NOTE: The pin will drop when pressed out of the bearing seat. It can be driven out with a drift punch and hammer.
- Remove the knuckle (7).



STEERING KNUCKLE INSTALLATION

- Place the steering knuckle (7) into the axle body.
- Oil the kin pin (10), insert it from below and drive it in with a plastic hammer.
- Press the pin (10) in fully with a jack (5).
- Fit the washer (8), screw on the nut (9) and tighten to 600 Nm.
- Fill lithium-based grease (Part No. 733 740 0160) at both grease nipples until grease emerges at the knuckle and axle body joint.
- Drive the roll pin (6) into the pin (4).
- Using special tool (2), hold the track rod and knuckle, and support them with a pipe (1) against the counterweight.
- Position the pin (4) at the knuckle and press the pin in until the roll pin contacts the knuckle.
- Remove the pipe (1) and pin (2) and drive in the second roll pin.

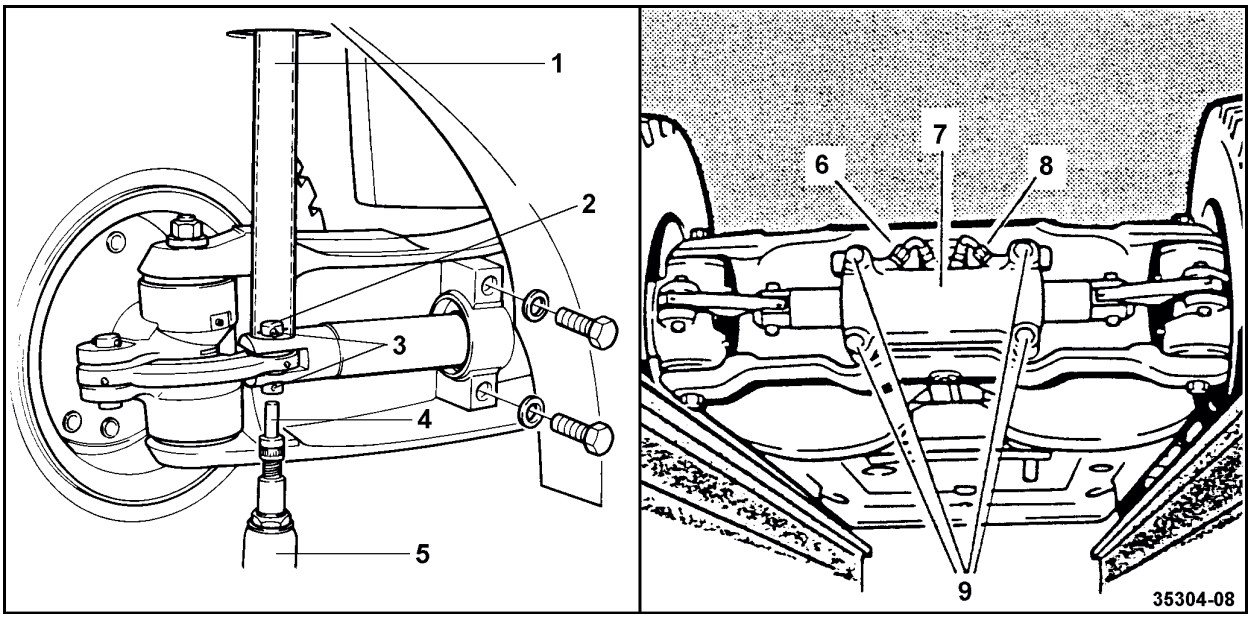
NOTE: King pin (10) and pin (4) must be free of dirt and rust.



4.4.4.3 STEERING CYLINDER REMOVAL AND INSTALLATION

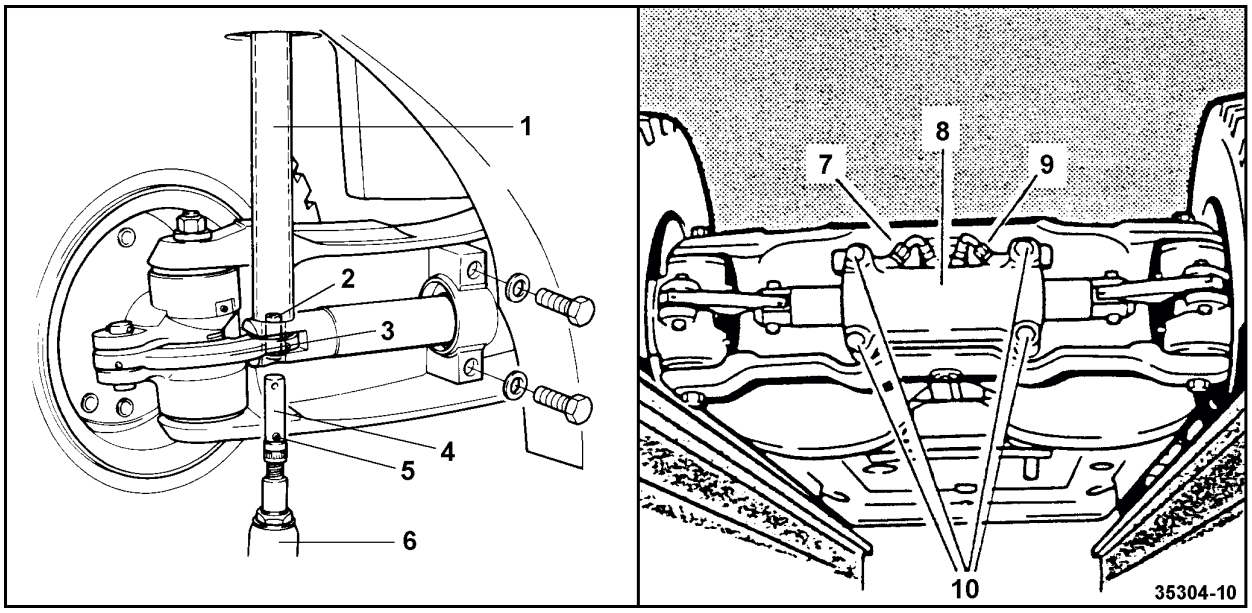
STEERING CYLINDER REMOVAL

- Jack up and securely block the rear of the truck so that the wheels can turn freely.
- Remove the dowel pins (3) from pin (2).
- Turn the steering wheel clockwise or anti-clockwise until the steering cylinder is extended as far as possible.
- Remove the four mounting screws (9) at the steering cylinder (7).
- Pull the steering cylinder (7) to the rear and so that the pin is positioned under the counterweight recess.
  NOTE: Support up the steering cylinder with wooden blocks.
- Position the pipe (1) over the pin collar and support it against the counterweight recess. Place the jack (5) on the ground, put the press-out pin (4) on the piston of the jack (5) and bring them in line.
- Operate the jack (5) to press out the pin (2).
- Press out the pin on the other side of the steering cylinder as described above.
- Disconnect hoses (6) and (8) at the steering cylinder.
- Remove the steering cylinder (7).



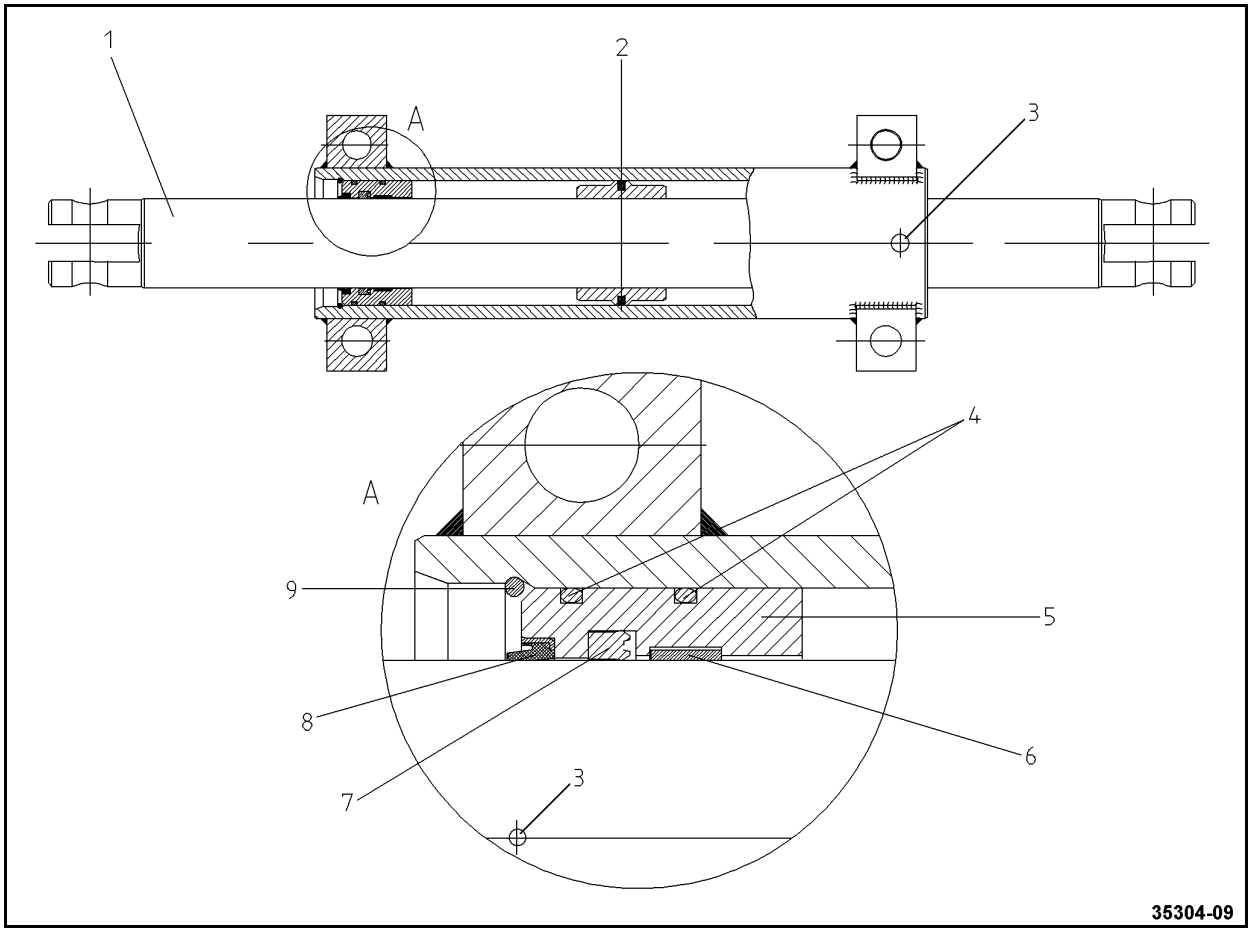
STEERING CYLINDER INSTALLATION

- Lift the steering cylinder (8) into the steering axle.
  NOTE: Support up the steering cylinder with wooden blocks.
  Steering cylinder holes have different diameters: diam. 24 mm at top, diam. 26 mm at bottom.
- Insert the track rod (3) into the fork on the steering cylinder (8) and bring them into alignment.
- Insert a centring pin (2) through the track rod (3) and fork on the piston rod of the steering cylinder (8).
- Support these with a pipe (1) placed between the counterweight and the fork on the piston rod of the steering cylinder (8).
- Drive a roll pin (5) into pin (4).
- Put the pin (4) into the fork on the piston rod of the steering cylinder (8) from below.
- Place a jack (6) on the ground under the pin (4).
- Operate the jack and press in the pin (4).
- Remove the pipe (1) and centring pin (2) and secure with a roll pin.
- Press the second pin in as describe above and secure with a roll pin.
- Screw the union nuts for the two hoses (7) and (9) onto the fittings on the steering cylinder and tighten them.
- Fasten the steering cylinder to the steering axle with the four fastening screws (10) and torque to 1050 Nm.
- Eliminate any air in the steering by turning the steering wheel several times through its full cycle and check the steering cylinder and connections for leaks.
- With the engine running, eliminate any air in the steering by turning the steering wheel through its full cycle several times and then check the steering cylinder and connections for leaks.

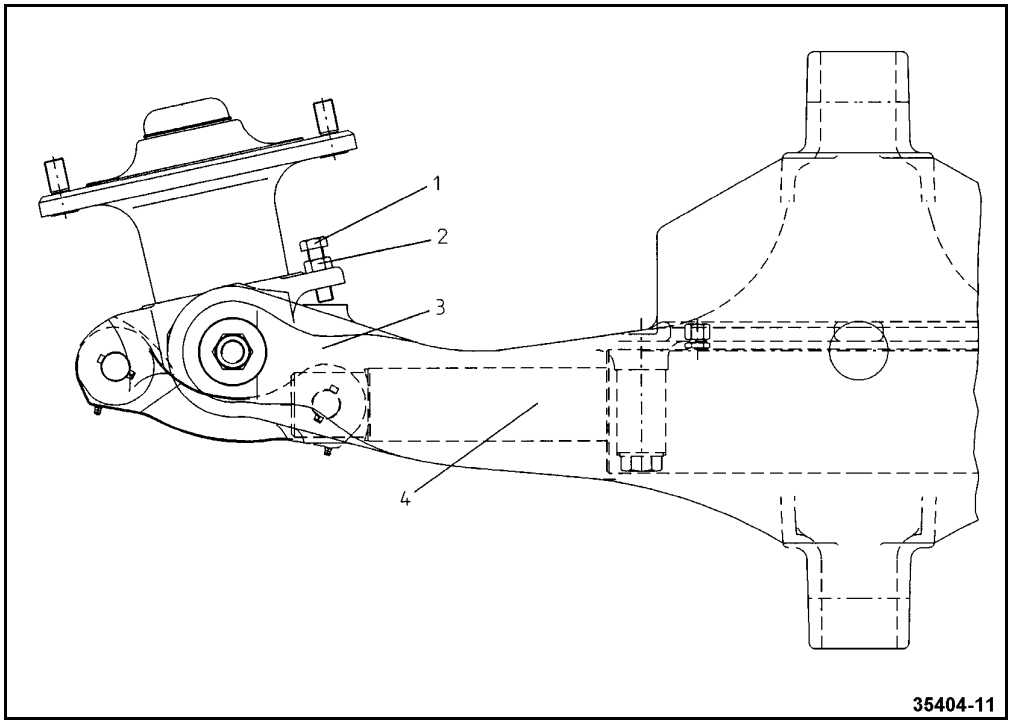


4.4.4.4 REPLACING THE STEERING CYLINDER SEALS

- Remove the steering cylinder and clamp it in a vise.
- Pull the piston rod (1) out to one side as far as possible.
- Drive in the guide bushing (5) approx. 1 - 2 mm.
- Loosen the retaining ring (9) with a 2.5 mm drift punch through hole (3) and remove with a screwdriver.
- Slide the piston rod in the direction of the removed snap ring and drive out the guide bushing (5) with light blows (plastic hammer) on the opposite end of the piston rod.
  NOTE: The piston rod can only be withdrawn if the connection for the hoses was removed.
- Pull the piston rod out of the cylinder and remove the guide bushing (5) from the piston rod.
- Remove the O-rings (4), grooved ring (7), wiper (8) and guide band (6) out of the guide bushing.
- Renew the O-rings, grooved ring, wiper and guide band, making sure that each sealing element is positioned correctly (see detail A).
- Remove the sealing ring (2) from the piston rod and replace with a new one.
- Remove the second retaining ring (9).
- Remove the guide bushing (5) and renew the sealing elements.
- Slightly grease or oil the guide bushing (5) and the cylinder barrel insert it into the cylinder, being sure that it is positioned correctly (chamfer on the outside circumference shows out).
- Install the retaining ring (9).
- Carefully insert the piston rod (1) into the cylinder from the opposite end and slide through the guide bushing (5) as far as the stop. Be sure not to damage the sealing lips of the sealing elements.
- Insert the second greased guide bushing (5), slide it in as far as the stop and secure it with the retaining ring (9).



4.4.4.5 STEERING STOP ADJUSTMENT



1 Stop screw
2 Locknut
3 Axle body
4 Steering cylinder

To prevent damage to the hydraulic cylinder, check and adjust, if necessary, the left and right-hand steering stop after repairing a steering knuckle, track rod or steering cylinder.

- Loosen the locknut (2) and screw out the M12x60 stop screw (1) approximately 10 turns.
- Start the engine and turn the steering wheel until the hydraulic cylinder is fully extended.
- Screw in the stop screw until it contacts the axle (3).
- Turn the steering wheel until the steering cylinder (4) is centred, screw in the stop screw (1) 2 to 3 turns and lock it with the nut (2).

NOTE: Adjust the steering stop on the other side as described above.

Service Training

4.5 CONTROLS

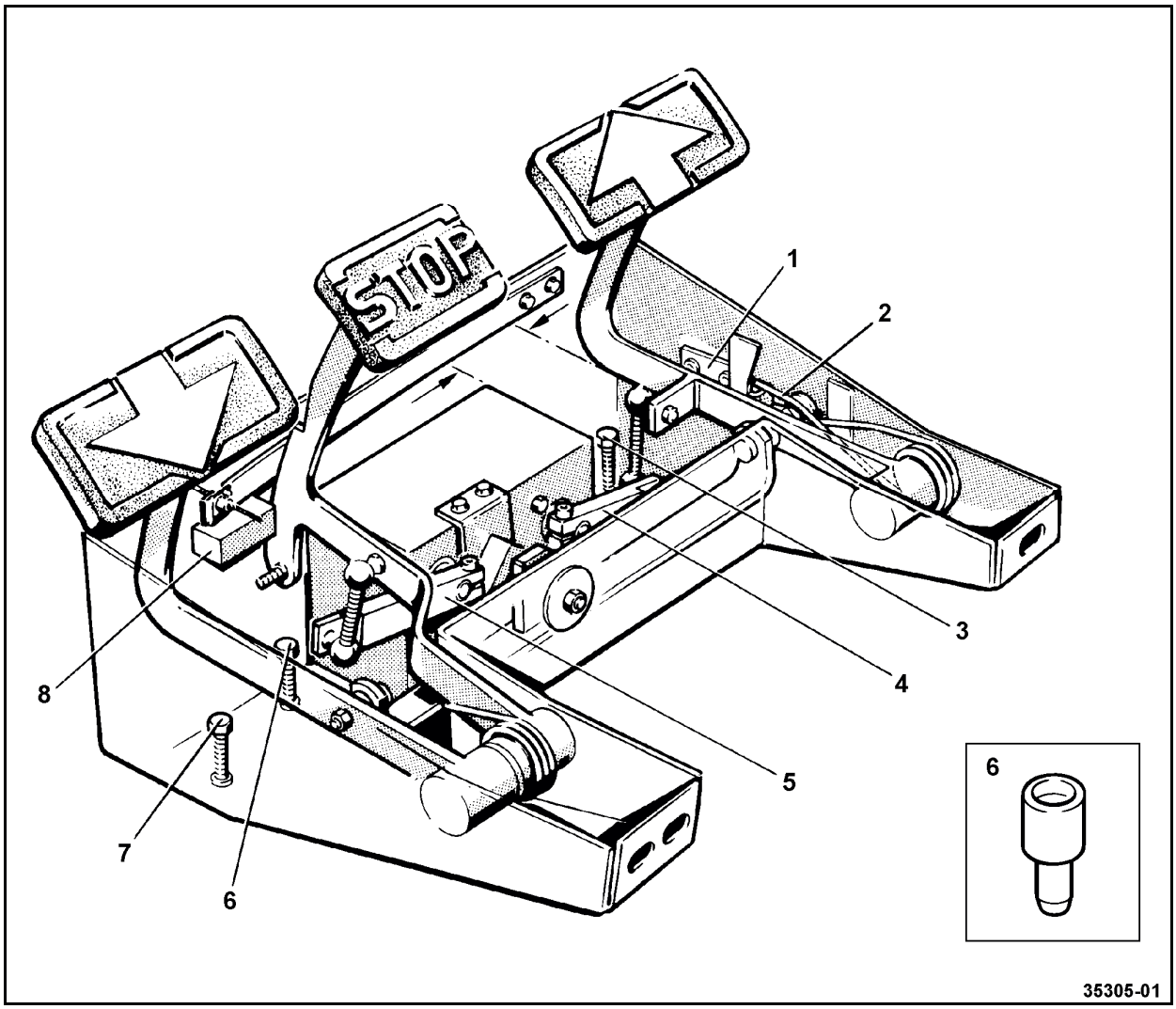
4.5.1 ACCELERATOR AND BRAKE PEDAL ADJUSTMENT

ACCELERATOR PEDALS

- Bring both accelerator pedals to the same level, position bracket (1) on the leg spring (2) and secure them with screws.
- With the aid of the spacer (WM 6), adjust the hexagonal screws (3) and (7) to a clearance of 48 mm from the pedal and lock them with locknuts.
- Position the travel control 55 mm (WM 6) from the side of the pedal and secure it with screws.
- Clamp the adjusting lever (4) on the travel control shaft (shaft is in the neutral position when delivered).

BRAKE PEDAL

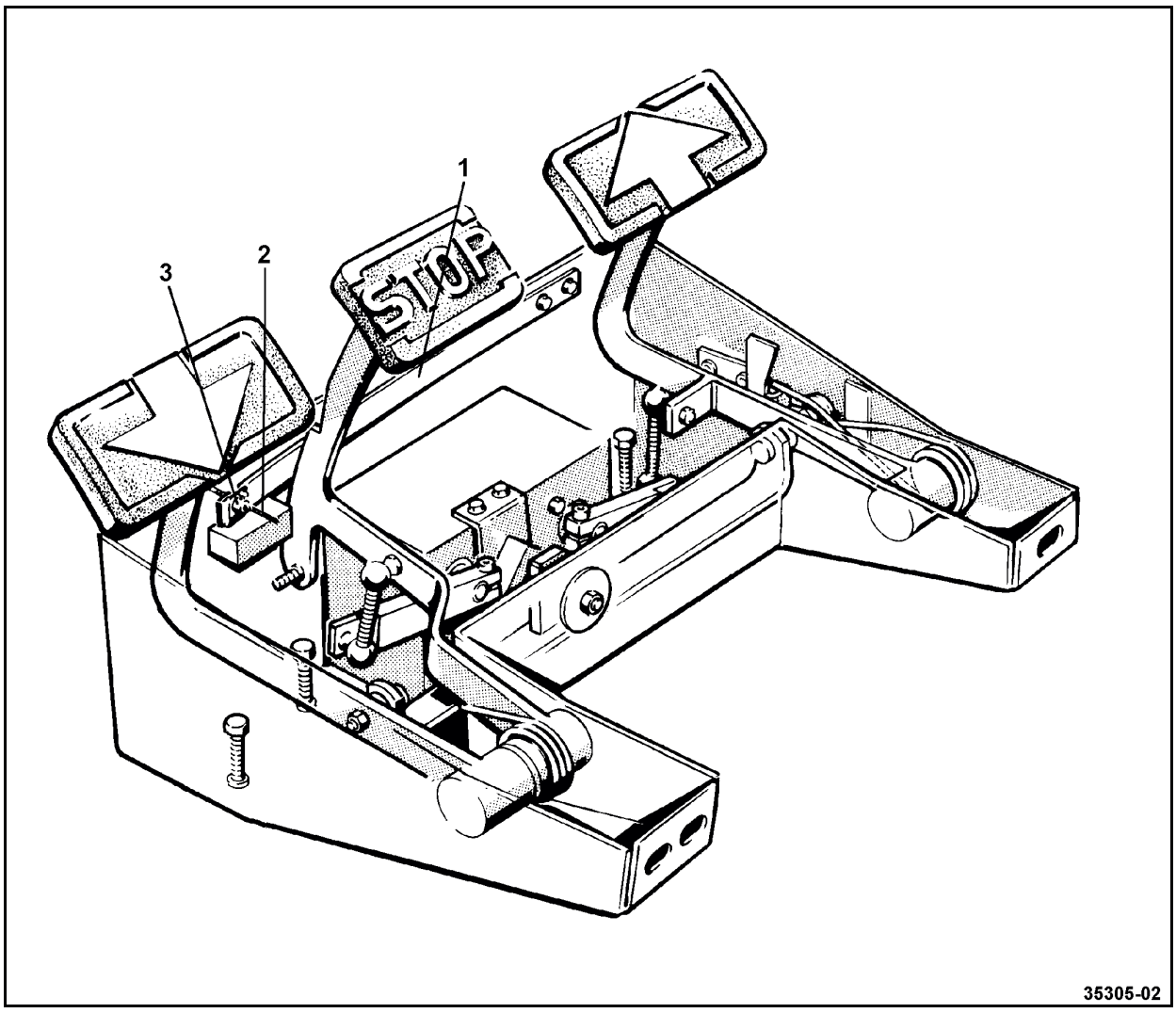
- Slide the stop (8) for the non-depressed pedal full up in the elongated holes.
- Slide the adjusting lever (5) onto the brake shaft of the control. Using a flat 10 mm spanner, turn the shaft clockwise as far as the stop and clamp the adjusting lever in this position.
- Slide the stop (8) in the elongated holes fully down and screw tight in this position. This will relieve the stress on the stop in the travel control.
- Using the spacer (WM 6), adjust the hexagonal screw (6) so that it is 48 mm from the pedal and lock it in this position with the locknut.


STOP
1
2
3
4
5
6
7
8
6
35305-01

Service Training

BOWDEN CABLE FOR THE PARKING BRAKE

- Depress the brake pedal until the flat spring (1) engages.
- Set the lever on the control unit cover to the "Brake engaged" position.
- Remove any play in the brake cable (2) at the lower end by clamping the nipple (3).



4.5.2 SPEED CONTROL

4.5.2.1 SPEED CONTROL UP TO 10/95

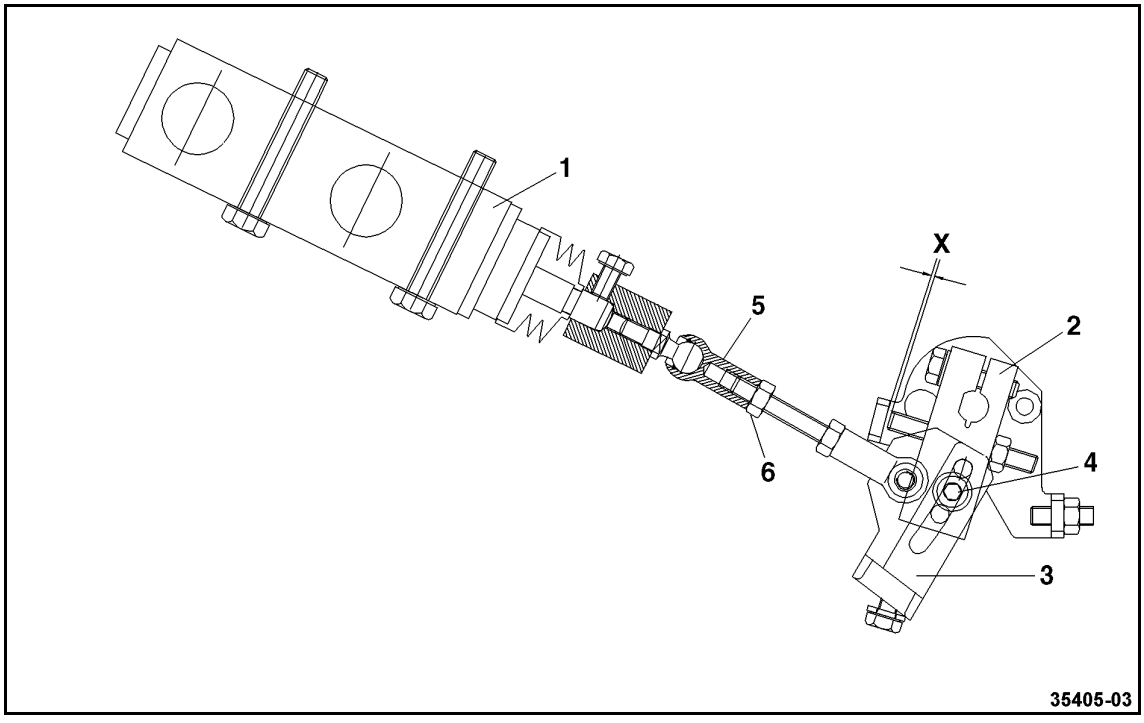
ADJUSTMENT INSTRUCTIONS FOR DIMENSION X (LOWER IDLING SPEED)

- Retract the speed control cylinder (1) and slacken screw (4). Shift the adjusting lever (3) outward as far as possible on lever (2).

- Tighten the screw (4).

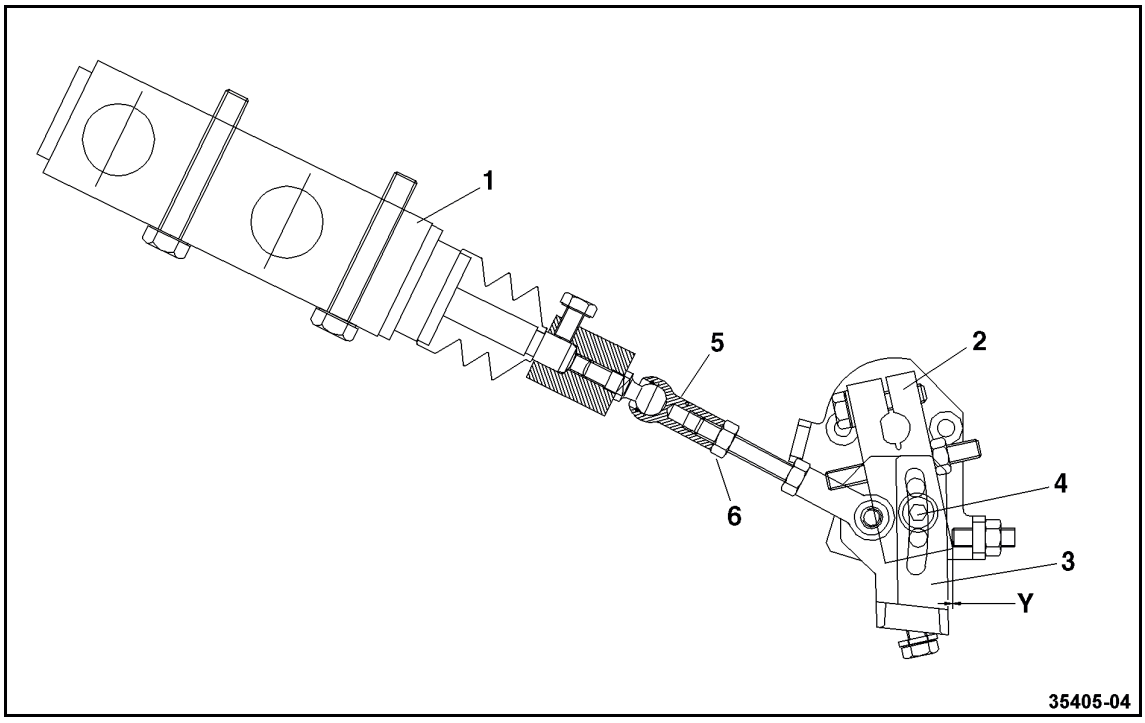
- Slacken nut (6) and adjust dimension X to 0.1 mm by turning the ball cup (5). Lock the nut (6) against the ball cup (5).

- Check dimension X with a 0.1 mm feeler gauge.



ADJUSTMENT INSTRUCTIONS FOR DIMENSION Y (UPPER IDLING SPEED)

- Fully depress the brake pedal and lock it.
- Start the engine.
- Depress the accelerator pedal until the speed control cylinder is fully extended.
- Slacken nut (4) and slide the adjusting lever (3) on lever (2).
- Adjust dimension Y to 0.1 mm.
- Tighten screw (4).
- Check dimension Y with a 0.1 mm feeler gauge.



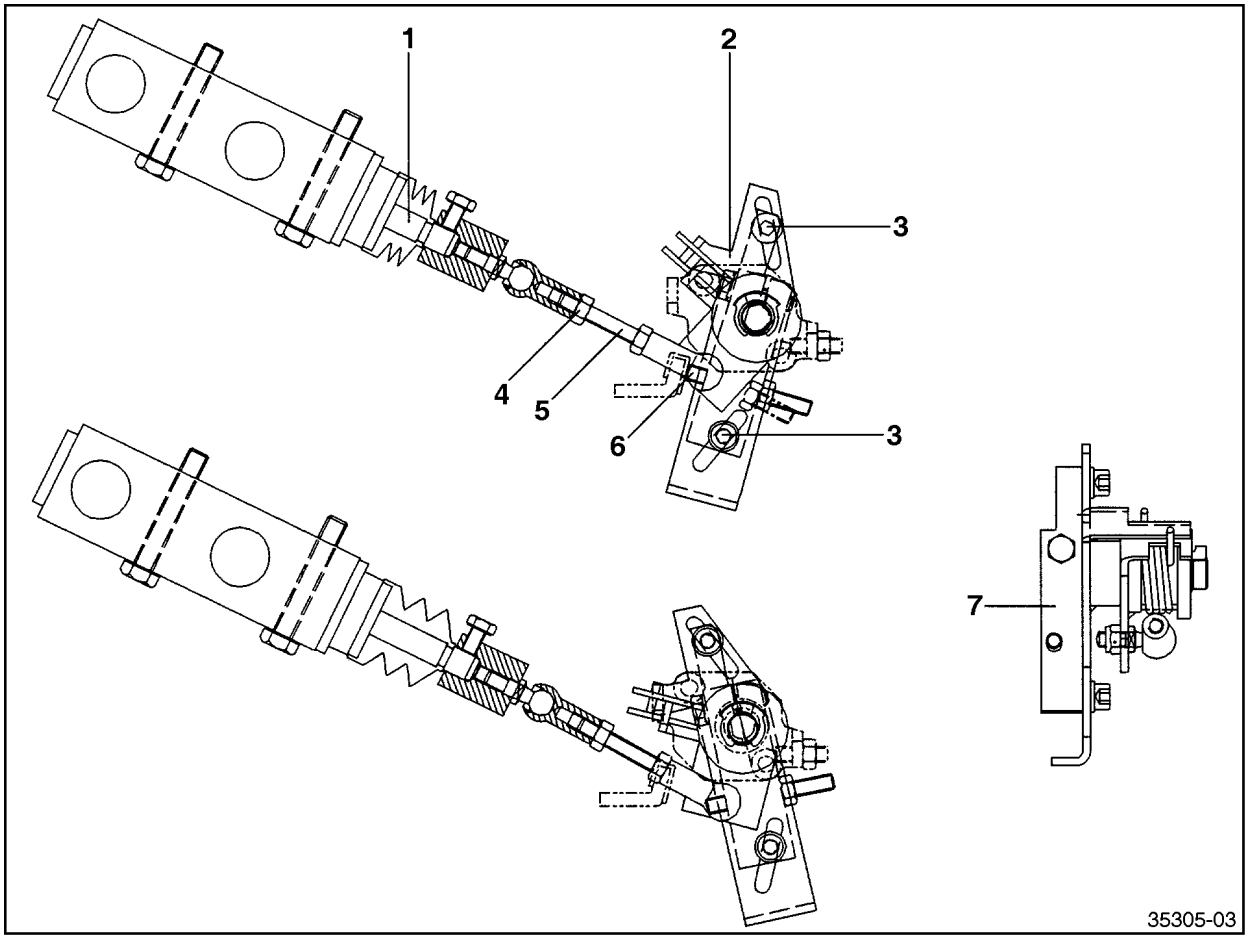
4.5.2.2 SPEED CONTROL FROM 11/95

From 11/95 the speed control lever has been provided with an overload protection. The adjustment procedure is as follows.

- With the control cylinder (1) retracted, slide the retainer (2) on the lever (7) as far as possible away from the engine and tighten both the cheese head screws (3).
- Move the lever as far as the low idle stop (6) by rotating the threaded rod (5) and lock the threaded rod with the nut (4).
- Start the engine and fully extend the control cylinder (1) by operating the accelerator.

NOTE: The brake pedal must be held in the fully depressed position.

- Loosen both cheese head screws (3).
- Slide the retainer (2) on the lever (7) as far as the upper idle stop and fix with the cheese head screws (3).
- Retract the control cylinder (1) to the home position and check the low idle stop again, readjust it if necessary.



4.5.3 MEDIUM WHEEL SPEED

CONDITIONS

- Jack up and securely block the truck so that the wheels can turn freely.
- Accelerator pedals and engine speed control correctly adjusted.
- Engine runs at 2250 - 2300 rpm with the accelerator pedals fully depressed.

CHECK

- Start the engine, release the brake and fully depress the right-hand accelerator pedal.

- In this position measure the speed of the left and right wheel and calculate the average of both speeds.

- Perform the same measurement with the left accelerator pedal depressed.

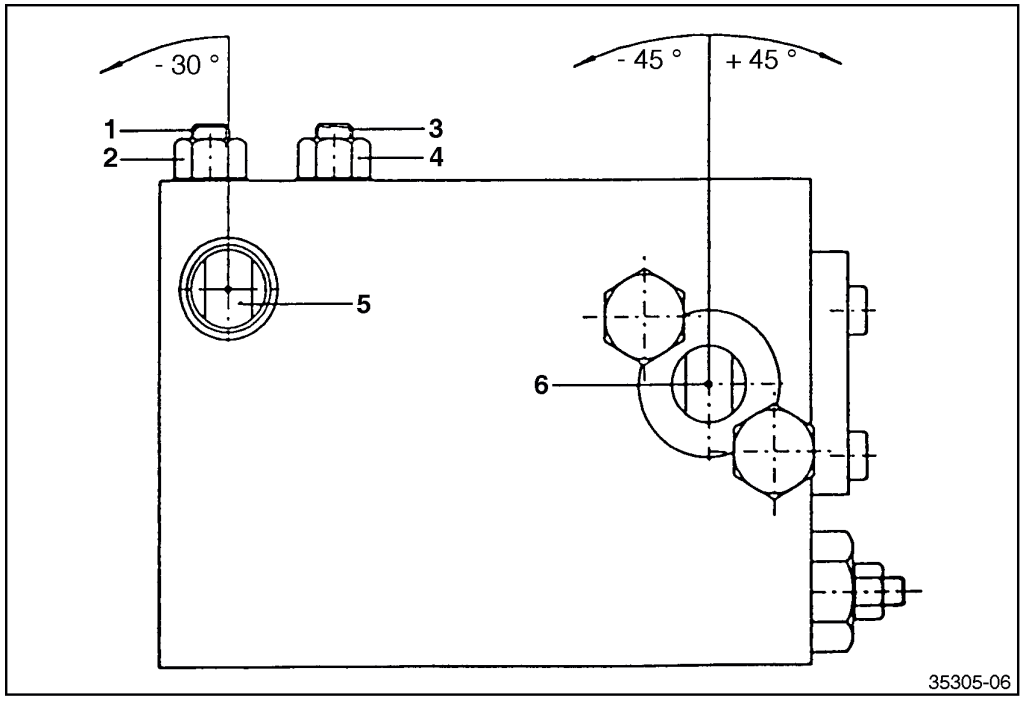
- Specified speed: 155 - 165 rpm

4.5.4 START OF DRIVE WHEEL ROTATION

The start of wheel rotation is set by means of setscrew (3) such that wheel rotation starts directly after the engine rpm increases or shortly thereafter. In no case should the start of wheel rotation begin before the engine speed starts to increase.

ADJUST CONDITIONS

- Pedal adjustment is in order.
- Block up the truck so that both drive wheels can turn freely.
- Engine and travel drive warmed up to operating temperature.
- Floor plate removed.
- Symmetry of speed control is in order.



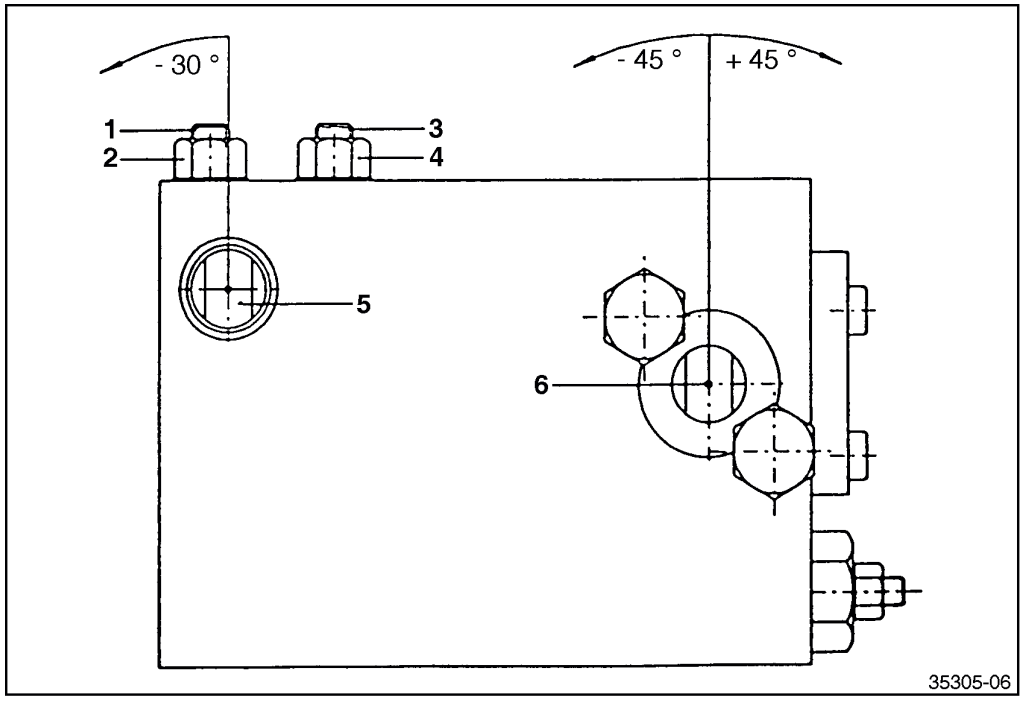
CHECK

- Start the engine and release the brake pedal.
- Depress the accelerator pedal for forward travel gently until the engine speed rises and the wheels start to rotate.
  If the start of wheel rotation follows directly or at the same time as the increase in speed, the adjustment is in order.
  If the wheels rotate before the engine speed rises, correct the setting as follows:
  Loosen locknut (4) and adjust the start of wheel rotation by turning screw (3).

NOTE: The adjustment range of screw (3) is 180 °, clockwise and counterclockwise. If it is not possible to perform the adjustment within this range, the start of control by the remote control for HPV 90 S or the operation cylinder of the speed control should be checked and adjkusted as required.

4.5.5 BRAKE SHAFT STOP SCREWS

- Connect a low pressure gauge to port BR on the travel control unit.
- Slacken the clamping screw on the brake lever and turn the brake shaft (5) clockwise as far as the stop.
- Loosen locknut (2).
- Start engine. Slowly screw in setscrew (1) while at the same time holding brake shaft (5) clockwise against the stop until the brake shaft has less clearance.
- Now gently screw out setscrew (1) while holding the brakeshaft clockwise against the stop until the maximum pressure is obtained. Then screw out setscrew a further ¼ turn and tighten locknut (2).
- Adjust the brake pedal as described in "Brake pedal".



4.5.6 SYMMETRY OF THE TRAVEL CONTROL

4.5.6.1 DRIVE WHEEL START OF ROTATION

ADJUSTMENT REQUIREMENTS

- Pedal adjustment is in order.
- Truck blocked up and secured so that both drive wheels can turn freely.
- Engine and traction hydraulics at operating temperature.
- Floor plate removed.
- Symmetry of speed control is in order.

CHECK

- Start the engine and release the brake.

- Slowly push down the forward pedal until the wheels begin to rotate. Measure the pedal stroke from the neutral position to start of rotation.

- Depress the reverse pedal until the start of rotation and also measure the pedal stroke.

The pedal stroke from neutral to the start of rotation should be equal for forward and reverse. Any noticeable difference should be corrected as follows.

- Stop the engine.

- Open the engine cover and remove the floor plate.

- Slacken the clamping screw on the travel control lever.

- Using a size 10 open-ended spanner, set the travel control shaft to the noticeable neutral range and tighten the clamping screw.

Should there still be a noticeable difference between forward and reverse, check equal pressure and the start of rotation. Refer to trouble-shooting procedures; adjust, if necessary.

4.5.6.2 ENGINE SPEED INCREASE

TEST REQUIREMENTS

- Truck blocked up and secured so that both wheels are free to rotate.
- Brake applied.
- Pedal adjustment is in order.

TEST

- Sit down on the driver's seat.
- Start the engine.

Test	Symptoms	Assessment
Gently push forward and reverse pedal until engine speed increases.	Speed increase with pedal stroke equal.	Symmetry in order.
	Speed increase with pedal stroke not equal.	No symmetry. Adjust by turning (in direction of travel) the front bushing on travel control unit.

4.5.7 PRESSURE DIFFERENCE ΔP

TEST REQUIREMENTS

- Truck blocked up.
- Engine and travel hydraulics at operating temperature.
- Pedal adjustment is in order.
- Symmetry of travel control is in order.
- Two low pressure gauges connected to ports Y and Z of travel control unit with screw couplings 1.1 (refer to "Aids and Tools for Measurements").

TEST

Test	Symptoms	Assessment
Start the engine. Release the brake. Alternately depress forward and reverse pedal as far as possible.	Δp between ports Y and Z rises to 11 $^{+0.1}$ bar.	Adjustment of pressure relief valve (34) in order.
	Δp between ports Y and Z does not rise to 11 $^{+0.1}$ bar or is larger.	Adjustment of pressure relief valve (34) not in order. Adjust as follows:

- Slacken locknut (7) at pressure relief valve (34).

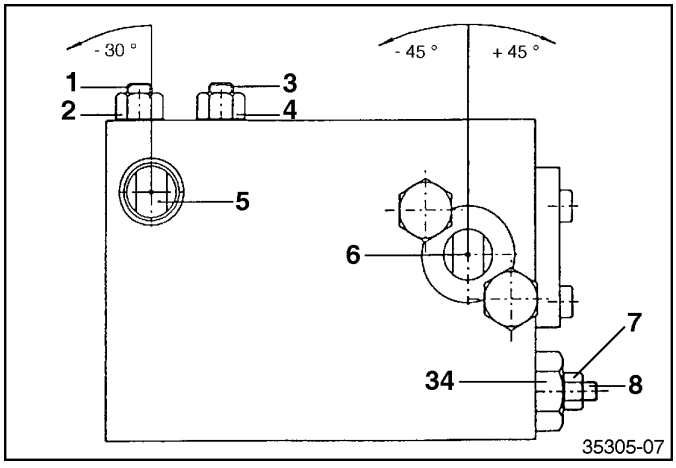
- If Δp was too large, turn screw (8) out.

- If Δp was too small, turn screw (8) in.

- Repeat the test.

- Tighten locknut (7).

If an adjustment is not possible, the travel control unit should be repaired or replaced.



4.5.8 MODIFICATION OF ENGINE ACCELERATION

In special cases it may be necessary to adapt the operating characteristics of the engine to the service conditions of the truck, e.g. very sensitive driving at creep speed without accelerating the engine, or frequent hill starts with a load at high engine speed. Both possibilities can be adjusted as described below.

Starting characteristics	Standard	Fast	Slow
Pedal stroke at the start of engine acceleration	approx. 15 mm	approx. 10 mm	approx. 17 mm
Pressure at control cylinder at the start of acceleration	approx. 6 bar	approx. 5 bar	approx. 7 bar
Modification of control cylinder	—	Remove 1 mm shim from control cylinder	Insert 1 mm shim in control cylinder
Δp Y/Z at start of traction wheel rotation	approx. 4 bar		
Low engine idle speed	approx. 800 rpm	approx. 820 rpm	approx. 750 rpm
Adjustment of accelerator sensor	The adjustment range of the setscrew (3), at the accelerator sensor, for the start of wheel rotation is 180 ° in both directions.		
Control characteristic of engine acceleration	Acceleration just before start of wheel rotation.	Acceleration well before start of wheel rotation.	Acceleration after start of wheel rotation.

4.6 ELECTRICAL SYSTEM

4.6.1 WIRING DIAGRAM

A1 Glow duration unit

F1 Fuse for glow duration unit, 80 A
F11 Fuse for indicator instrument, 5 A
F13 Fuse for glow duration unit/soot filter power supply, 5 A
F14 Fuse for shut-off magnet, 5 A
F16 Fuse for potential 30, not used, 15 A
4F12 Fuse for horn, 15 A

G1 Alternator with regulator
G2 Battery, 143 Ah

H1 Charging indicator light
H2-3 Engine temperature warning light
H4 Hydraulic oil temperature warning light
H5 Engine oil pressure warning light
H6 Suction filter vacuum indicator light
H12 Flasher indicator light
H13 Fuel level warning light
H24 Fan
H25 Preheating
H26 Soot filter warning light
4H7 Horn

K2 Starter relay
K3 Signal transmission relay, preheating

M1 Starter, 3.1 kW

P1 Hour meter
6P3 Composite instrument

R1 Glow plugs

S1 Preheat/starter switch
S2 Engine temperature switch
S3 Oil temperature switch
S4 Oil pressure switch
S5 Suction filter vacuum switch
S6 Fuel level warning switch
S7 Temperature switch for richer fuel mixture
S8 Horn button
S14 Starter lockout switch
S18 Coolant level sensor

V1/2/3 Decoupling diodes

X1-X10 Connector

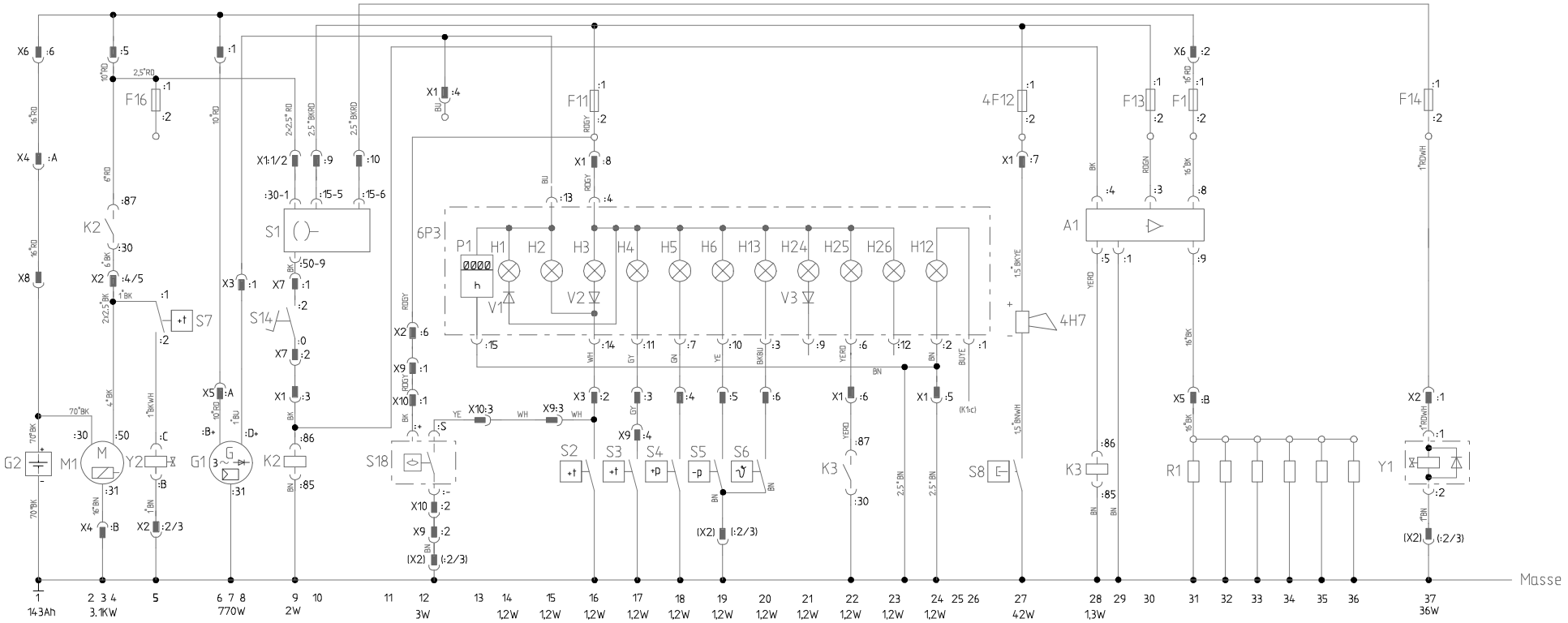
Y1 Shutoff magnet
Y2 Magnet for richer fuel mixture

CABLE COLOURS

BU blue
BN brown
YE yellow
GY gray
GN green
OG orange
RD red
BK black
WH white
VT violet

Service Training

CIRCUIT DIAGRAMM H 50/60/70/80, TYPE 353



4.6.2 WIRING DIAGRAM FOR OPTIONS

5E2	Dip beam, right
5E3	Dip beam, left
5E4	Side light, front right
5E5	Side light, front left
5E6	Side light, rear left
5E7	Side light, rear right
5E8	License plate light
9E1-9E6	Spotlight
9E13	Interior light
(F11)	Fuse, spotlight indicator light - 5 A
5F23	Fuse, interior light, 5 A
5F31,32	Fuses, directional indicators, 15 A
5F33	Fuse, left side lights, 15 A
5F34	Fuse, right side lights, 15 A
5F35	Fuse, left dip beam, 15 A
5F36	Fuse, right dip beam, 15 A
9F15	Fuse, heater, revolving light, 20 A
9F16	Fuse, single-pedal model, 5 A
9F21	Fuse, front windscreen wiper, 15 A
9F22	Fuse, rear / roof windscreen wiper, 15 A
9F24-26	Fuses, spotlight, 20 A
4H14	Revolving light
4H15	Switch lighting
5H8	Directional indicator, front left
5H9	Directional indicator, rear left
5H10	Directional indicator, front right
5H11	Directional indicator, rear right
5H12,13	Switch lighting, 1.2 W
9H1-9H6	Switch lighting, 1.2 W
5K1	Direction indicator switch
9K1	Intermittent relay, front wiper
9K2	Intermittent relay, rear/roof wiper
9K3	Rear wiper motor relay
9M1	Wiper motor, front
9M2	Washer, front
9M3	Wiper motor, roof
9M4	Wiper motor, rear
9M5	Washer, rear/roof
4S15	Revolving light switch
5S11	Light switch
5S12	Hazard warning light switch
5S13	Directional indicator switch
9S1	Front wiper switch - continuous
9S2	Front wiper switch - wiper-washer, intermittent
9S3	Rear/roof wiper switch - continuous
9S4	Rear/roof wiper switch - wiper-washer, intermittent
9S5,6	Spotlight switch
9S7	Travel direction switch, single-pedal model
4X1-9X14	Connector
9Y3/4	Solenoid valve, single-pedal model

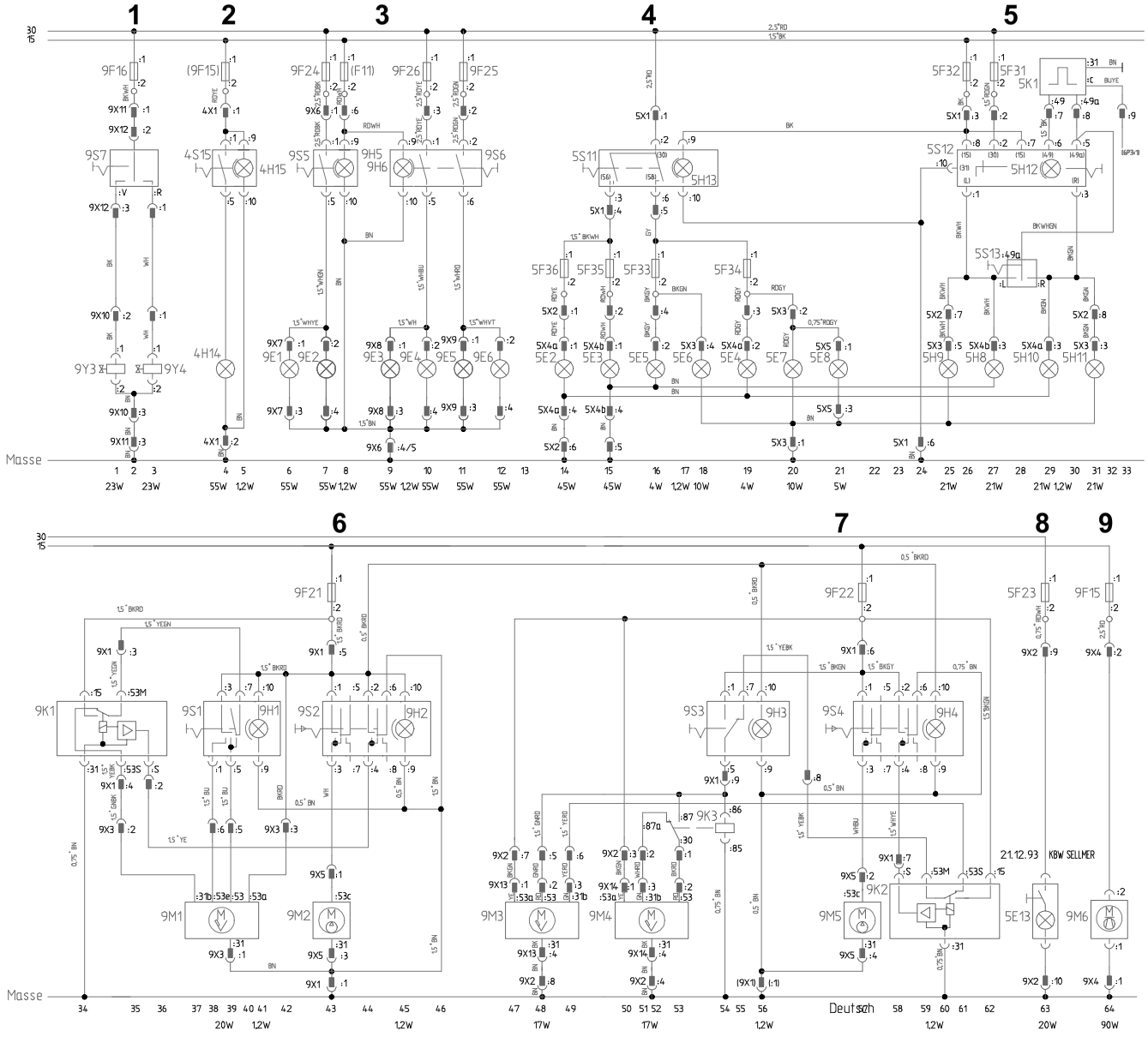
CABLE COLOURS

BU	blue
BN	brown
YE	yellow
GY	gray
GN	green
OG	orange
RD	red
BK	black
WH	white
VT	violet

OPTIONS

1	Single-pedal model
2	Revolving light
3	Spotlight
4	Lighting
5	Directional indicator and hazard warning system
6	Front windscreen wiper
7	Roof and rear windscreen wiper
8	Interior light
9	Heater

CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80, TYPE 353



4.6.3 WIRING DIAGRAM, 353 -02

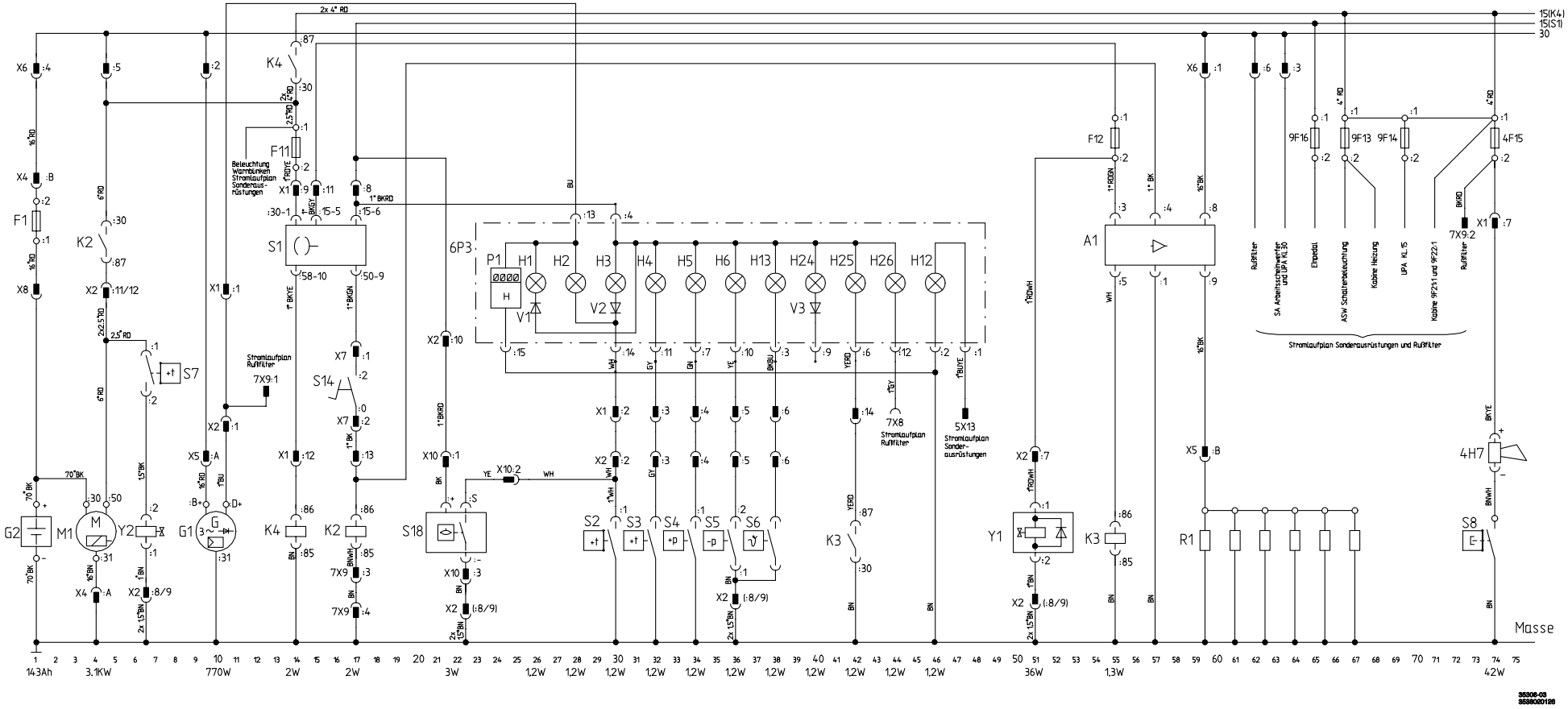
A1	Glow duration unit	55-60
F1	Fuse for glow duration unit, 80 A	1
F11	Fuse for potential 30, S1, 10 A	14
F12	Fuse glow duration unit/ shut-off magnet 10 A	55
4F15	Fuse for horn, 10 A	
9F13	Fuse for working lights switch illumination/Heater 15 A	
9F14	Fuse for UPA, max. 20 A	69
9F16	Fuse for single pedal, option	65
G1	Alternator with regulator	10
G2	Battery	1
H1	Charging indicator light	26
H2-3	Engine temperature warning light	28, 30
H4	Hydraulic oil temperature warning light	32
H5	Engine oil pressure warning light	34
H6	Suction filter vacuum indicator light	36
H12	Flasher indicator light	46
H13	Fuel level warning light	38
H24	Fan	40
H25	Preheating	42
H26	Soot filter warning light	44
4H7	Horn	74
K2	Starter relay	4, 17
K3	Signal transmission relay, preheating	55
K4	Additional relay, potential 15	14
M1	Starter	4
P1	Hour meter	24
6P3	Composite instrument	22 - 48
R1	Glow plugs	59 - 67
S1	Preheat/starter switch	14 - 17
S2	Engine temperature switch	30
S3	Oil temperature switch	32
S4	Oil pressure switch	34
S5	Suction filter vacuum switch	36
S6	Fuel level warning switch	38
S7	Temperature switch for richer fuel mixture	7
S8	Horn button	74
S14	Starter lockout switch	17
S18	Coolant level sensor	20 - 23

V1/2/3	Decoupling diodes	26, 28, 40
X1	Connector 15 pins	11 - 17, 30 - 42, 74
X2	Connector 12 pins	4 - 22, 30 - 38, 51
X4	Connector 2 pins	1, 4
X5	Connector 2 pins	9, 59
X6	Connector 6 pins	1, 5, 10, 60 - 64
X7	Connector 2 pins	17
X8	Connector 1 pin	1
X10	Connector 3 pins	21 - 25
5X13	Connector 1 pin	47
7X8	Connector 1 pin	44
7X9	Connector 6 pins	12, 17, 72
Y1	Shutoff magnet	50 - 52
Y2	Magnet for richer fuel mixture	6

CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	gray
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

CIRCUIT DIAGRAMM H 50/60/70/80 -02, TYPE 353



4.6.4 WIRING DIAGRAM FOR OPTIONS, 353 -02

5E2	Dip beam, right	25
5E3	Dip beam, left	28
5E4	Side light, front right	35
5E5	Side light, front left	30
5E6	Side light, rear left	33
5E7	Side light, rear right	38
5E8	License plate light	40
9E1-9E6	Spotlight	10 - 22
9E13	Interior light	56
5F31,32	Fuses, directional indicators, 15 A	44 - 46
5F33	Fuse, left side lights, 5 A	30
5F34	Fuse, right side lights, 5 A	35
5F35	Fuse, left dip beam, 10 A	28
5F36	Fuse, right dip beam, 10 A	25
9F13	Fuse for heater, switch illumination working lights 15 A	14, 59
9F14	Fuse for UPA potential 15, 20 A	7, 62
9F16	Fuse, single-pedal model, 5 A	2
9F21	Fuse, front windscreen wiper, 15 A	56, 87
9F22	Fuse, rear / roof windscreen wiper, 15 A	123
9F23	Fuse for UPA potential 30, 20 A	9
9F24-26	Fuses, spotlight, 15 A	12, 18, 20
5H8	Directional indicator, front left	46
5H9	Directional indicator, rear left	43
5H10	Directional indicator, front right	49
5H11	Directional indicator, rear right	51
5H12,13	Switch lighting, 1.2 W	32, 49
9H1-9H6	Switch lighting, 1.2 W	14, 16, 87, 95, 123
5K1	Direction indicator switch	49 - 51
9K1	Intermittent relay, front wiper	72 - 77
9K2	Intermittent relay, rear/roof wiper	110 - 115
9K3	Rear wiper motor relay	101 - 104
9M1	Wiper motor, front	73 - 76
9M2	Wiper motor, rear	101 - 104
9M4	Washer, rear/roof	129
9M6	Fan	59
9M10	Wiper motor, roof	109 - 112
9M11	Washer, front	126

5S11	Light switch	27 - 33
5S12	Hazard warning light switch	44 - 51
5S13	Directional indicator switch	46 - 48
9S1	Front wiper switch	82 - 87
9S2	Rear/roof wiper switch	118 - 124
9S3	wiper switch, wash	90 - 96
9S5,6	Spotlight switch	12 - 21
9S7	Travel direction switch, single-pedal model	1 - 3
5X1	Connector 15 pins	25 - 36, 43 - 53
5X3	Connector 6 pins	33, 38, 43, 51
5X4a	Connector 6 pins	25, 35, 49
5X4b	Connector 6 pins	28, 31, 46
5X5	Connector 3 pins	40
5X11	Connector 6 pins	33, 38, 43, 51
5X13	Connector 1 pin	53
9X1	Connector 9 pins	59, 71 - 76, 87, 110 - 113
9X2	Connector 6 pins	56, 100 - 116
9X3	Connector 6 pins	73 - 76
9X4	Connector 9 pins	56, 100 - 112, 123
9X5	Connector 2 pins	129
9X6	Connector 4 pins	13 - 20
9X7	Connector 6 pins	10, 12
9X8	Connector 6 pins	16, 18
9X9	Connector 6 pins	20, 22
9X10	Connector 3 pins	1 - 3
9X11	Connector 3 pins	2
9X12	Connector 3 pins	1 - 3
9X13	Connector 4 pins	109, 111
9X14	Connector 4 pins	102, 104
9X15	Connector 2 pins	126
1Y1	Solenoid valve, single-pedal model, forward	3
1Y2	Solenoid valve, single-pedal model, reverse	1

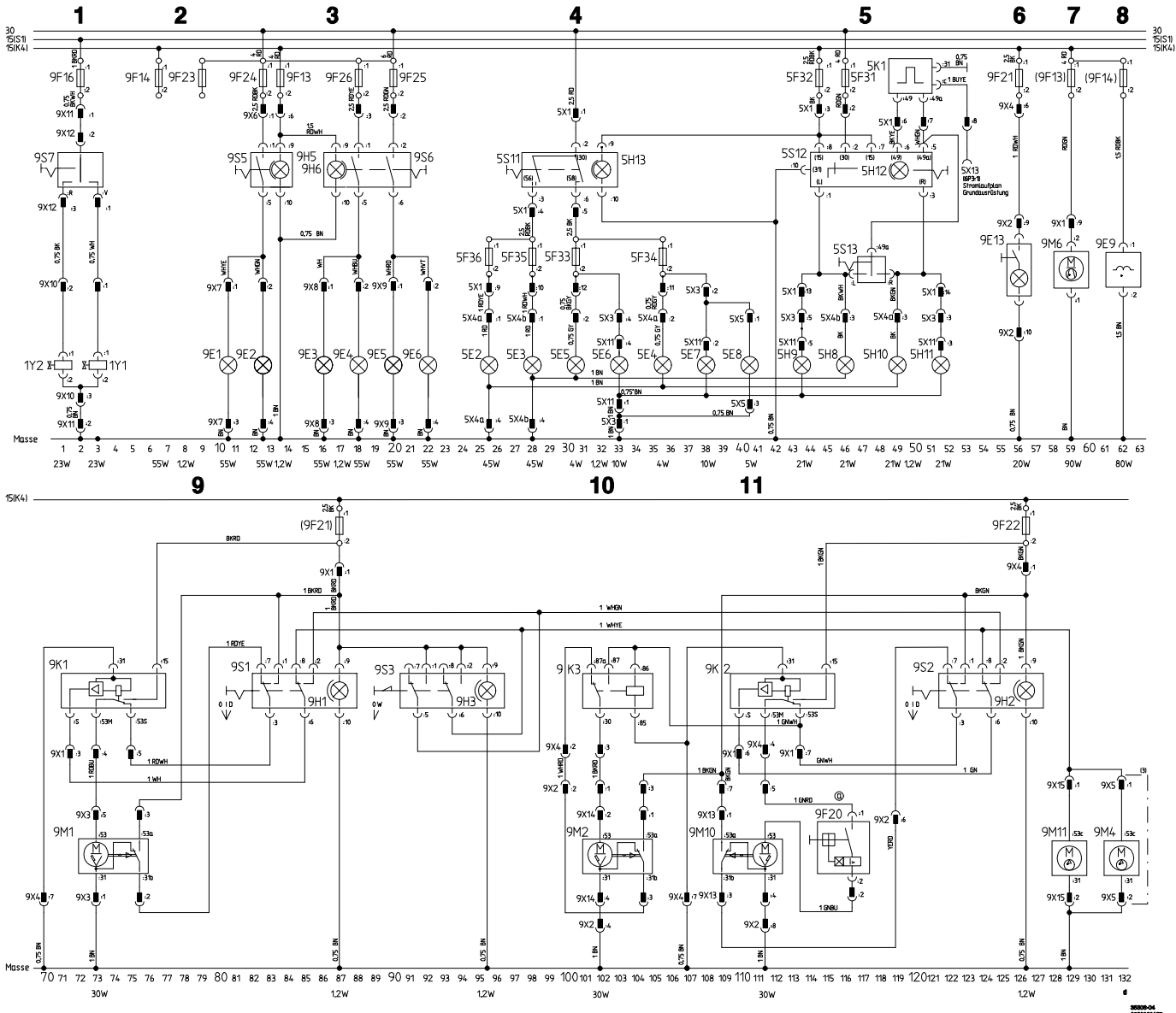
CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	gray
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

OPTIONS

1	Single-pedal model
2	Revolving light
3	Spotlight
4	Lighting
5	Directional indicator and hazard warning system
6	Front windscreen wiper
7	Roof and rear windscreen wiper
8	Interior light
9	Heater

CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80 -02, TYPE 353



4.6.5 WIRING DIAGRAM, 353 -03 DIESEL

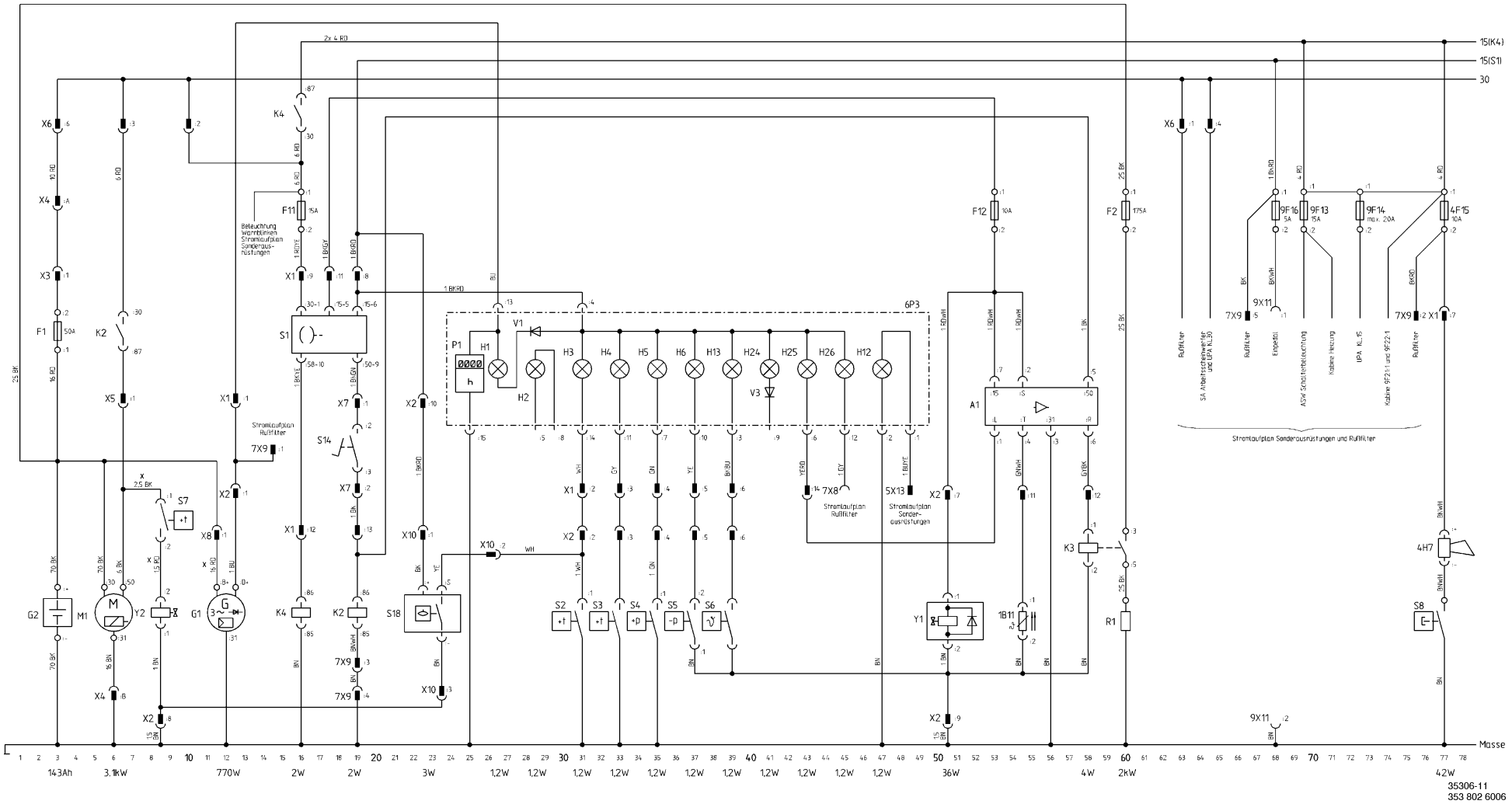
A1	Control device for heater flange	53-58
1B11	Cooling water temperature sensor	54
F1	Fuse MTA	3
F2	Fuse for heater flange	60
F11	Fuse for potential 30, S1	16
F12	Fuse for heater flange control device/ shut-off magnet	53
4F15	Fuse for horn	77
9F13	Fuse for working lights switch illumination/Heater	69
9F14	Fuse for UPA	72
9F16	Fuse for single pedal	68
G1	Alternator with regulator	11-13
G2	Battery	3
H1	Charging indicator light	26
H2	Electrical control warning light	28
H3	Engine temperature warning light	31
H4	Hydraulic oil temperature warning light	33
H5	Engine oil pressure warning light	35
H6	Suction filter vacuum indicator light	37
H12	Flasher indicator light	47
H13	Fuel level warning light	39
H24	Fan	41
H25	Preheating	43
H26	Soot filter warning light	45
4H7	Horn	77
K2	Starter relay	6, 19
K3	Heater flange relay	58-60
K4	Additional relay, potential 15	16
M1	Starter	5-7
P1	Hour meter	25
6P3	Composite instrument	24-49
R1	Heater flange	60
S1	Preheat/starter switch	16-19
S2	Engine temperature switch	31
S3	Oil temperature switch	33
S4	Oil pressure switch	35
S5	Suction filter vacuum switch	37
S6	Fuel level warning switch	39

S7	Temperature switch for richer fuel mixture	9
S8	Horn button	77
S14	Brake pedal switch (start inhibit)	19
S18	Coolant level sensor	22-24
V1/3	Decoupling diodes	29,41
X1	Connector 15 pins	12-19, 31-43, 77
X2	Connector 12 pins	8-22, 31-39, 50-58
X3	Connector 1 pin	3
X4	Connector 2 pins	3, 6
X5	Connector 1 pin	6
X6	Connector 6 pins	3-10, 63, 65
X7	Connector 2 pins	19
X8	Connector 1 pin	11
X10	Connector 3 pins	222,23,26
5X13	Connector 1 pin	48
7X8	Connector 1 pin	45
7X9	Connector 6 pins	14, 19, 65, 75
9X11	Connector 3 pins	68
Y1	Shutoff magnet	50 - 52
Y2	Magnet for richer fuel mixture	8

CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	gray
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

CIRCUIT DIAGRAMM H 50/60/70/80 -03, TYPE 353 DIESEL



4.6.6 WIRING DIAGRAM FOR OPTIONS, 353 -03

5E2	Dip beam, right	27
5E3	Dip beam, left	30
5E4	Side light, front right	40
5E5	Side light, front left	32
5E6	Side light, rear left	37
5E7	Side light, rear right	45
5E8	License plate light	47
5E10	Position light, right	42
5E11	Position light, left	35
9E1-9E6	Spotlight	11-24
9E9	Seat heating	75
9E13	Interior light	66
5F31,32	Fuses, directional indicators	41, 54
5F33	Fuse, left side lights	32
5F34	Fuse, right side lights	40
5F35	Fuse, left dip beam	30
5F36	Fuse, right dip beam	27
9F13	Fuse for heater, switch illumination working lights	15, 71
9F14	Fuse for UPA potential 15	7, 75
9F16	Fuse, single-pedal model	2
9F20	Fuse for magnetic protective switch	129-131
9F21	Fuse, front windscreen wiper	66, 99
9F22	Fuse, rear / roof windscreen wiper	141
9F23	Fuse for UPA potential 30	10
9F24-26	Fuses, spotlight	13, 20, 22
5H8	Directional indicator, front left	53
5H9	Directional indicator, rear left	50
5H10	Directional indicator, front right	56
5H11	Directional indicator, rear right	58
5H12,13	Switch lighting	34, 56
9H1-9H3	Switch illumination	99,107,141
9H5-9H6	Switch lighting	15, 19
5K1	Direction indicator switch	56-58
9K1	Intermittent relay, front wiper	83-89
9K2	Intermittent relay, rear/roof wiper	124-130
9K3	Rear wiper motor relay	114-118
9M1	Wiper motor, front	84-88
9M2	Washer, front	144
9M3	Wiper motor, roof	122-125
9M4	Wiper motor, rear	114-118
9M5	Washer, rear/roof	147
5S11	Light switch	29 - 35
5S12	Hazard warning light switch	51 - 59
5S13	Directional indicator switch	53 - 56

9S1	Front wiper switch	93 - 99
9S2	Rear/roof wiper switch	135 - 142
9S3	wiper switch, wash	101 - 108
9S5,6	Spotlight switch	13 - 24
9S7	Travel direction switch, single-pedal model	2 - 5
1V11	Free-wheeling diode	7
1V12	Free-wheeling diode	1
5X1	Connector 15 pins	27 -40, 50 - 61
5X3	Connector 6 pins	37, 45, 50 ,58
5X5	Connector 3 pins	47
5X7	Connector 6 pins	27, 40, 56
5X8	Connector 6 pins	30, 32, 53
5X11	Connector 6 pins	37, 45, 50, 58
5X13	Connector 1 pin	61
5X14	Connector 2 pins	35
5X15	Connector 2 pins	42
9X1	Connector 9 pins	71, 84 - 87, 99, 124 - 134, 141
9X2	Connector 6 pins	112 - 126, 134
9X3	Connector 6 pins	85, 87
9X4	Connector 9 pins	66, 112, 115, 125, 134
9X5	Connector 2 pins	147
9X6	Connector 4 pins	13, 22
9X7	Connector 6 pins	11, 13
9X8	Connector 6 pins	18, 20
9X9	Connector 6 pins	22, 24
9X10	Connector 4 pins	3 - 5
9X11	Connector 3 pins	4
9X12	Connector 3 pins	3 - 5
9X13	Connector 4 pins	122, 124
9X14	Connector 4 pins	115, 117
9X15	Connector 2 pins	144
1Y1	Solenoid valve, single-pedal model, forward	5
1Y2	Solenoid valve, single-pedal model, reverse	3

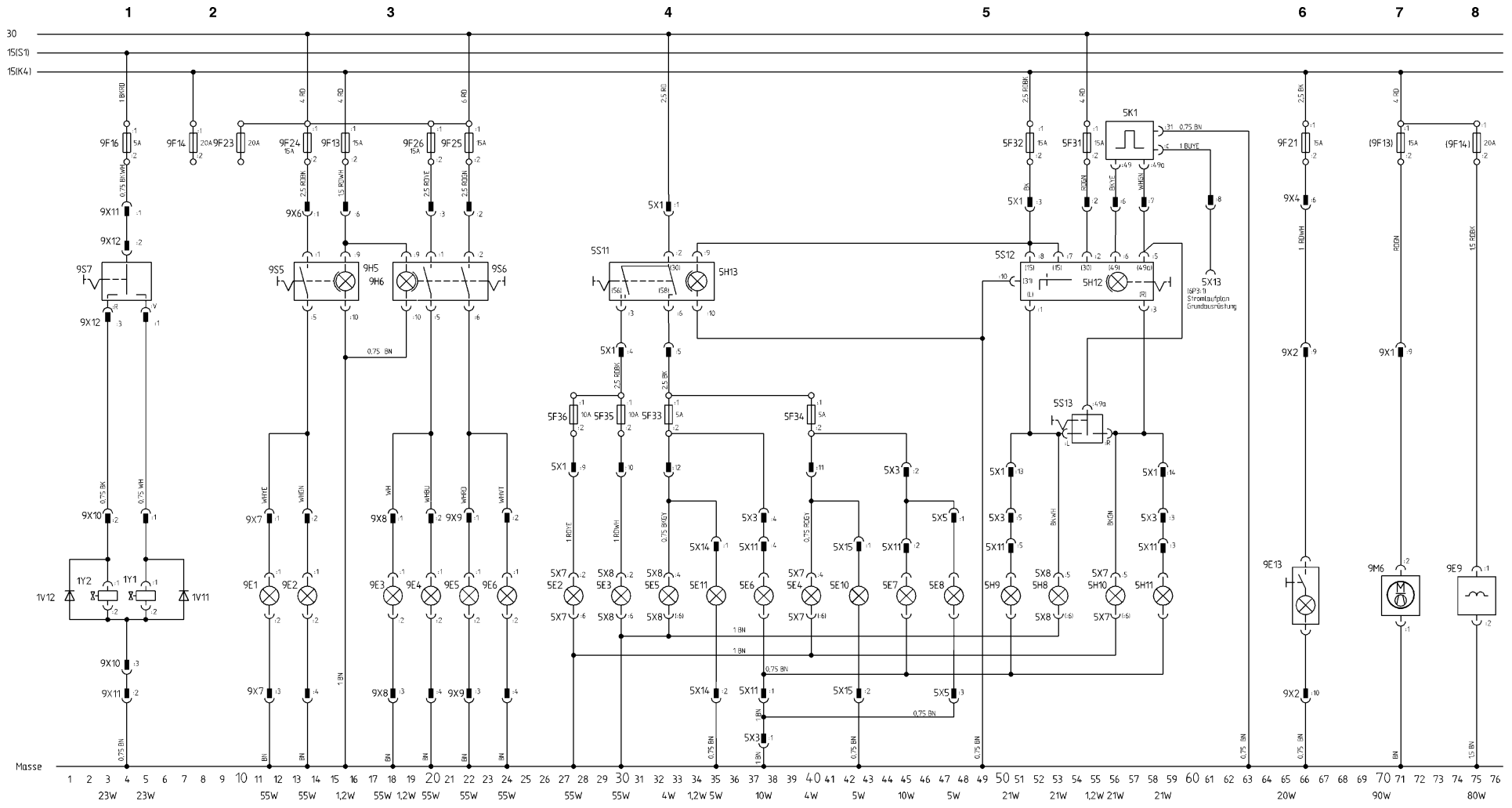
CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	grey
OR	orange
RD	red
YE	yellow
VT	violet

OPTIONS

1	Single-pedal model
2	UPA
3	Spotlight
4	Lighting
5	Directional indicator and hazard warning system
6	Interior light
7	Heater
8	Seat heating
9	Front windscreen wiper
10	Rear windscreen wiper
11	Roof windscreen wiper

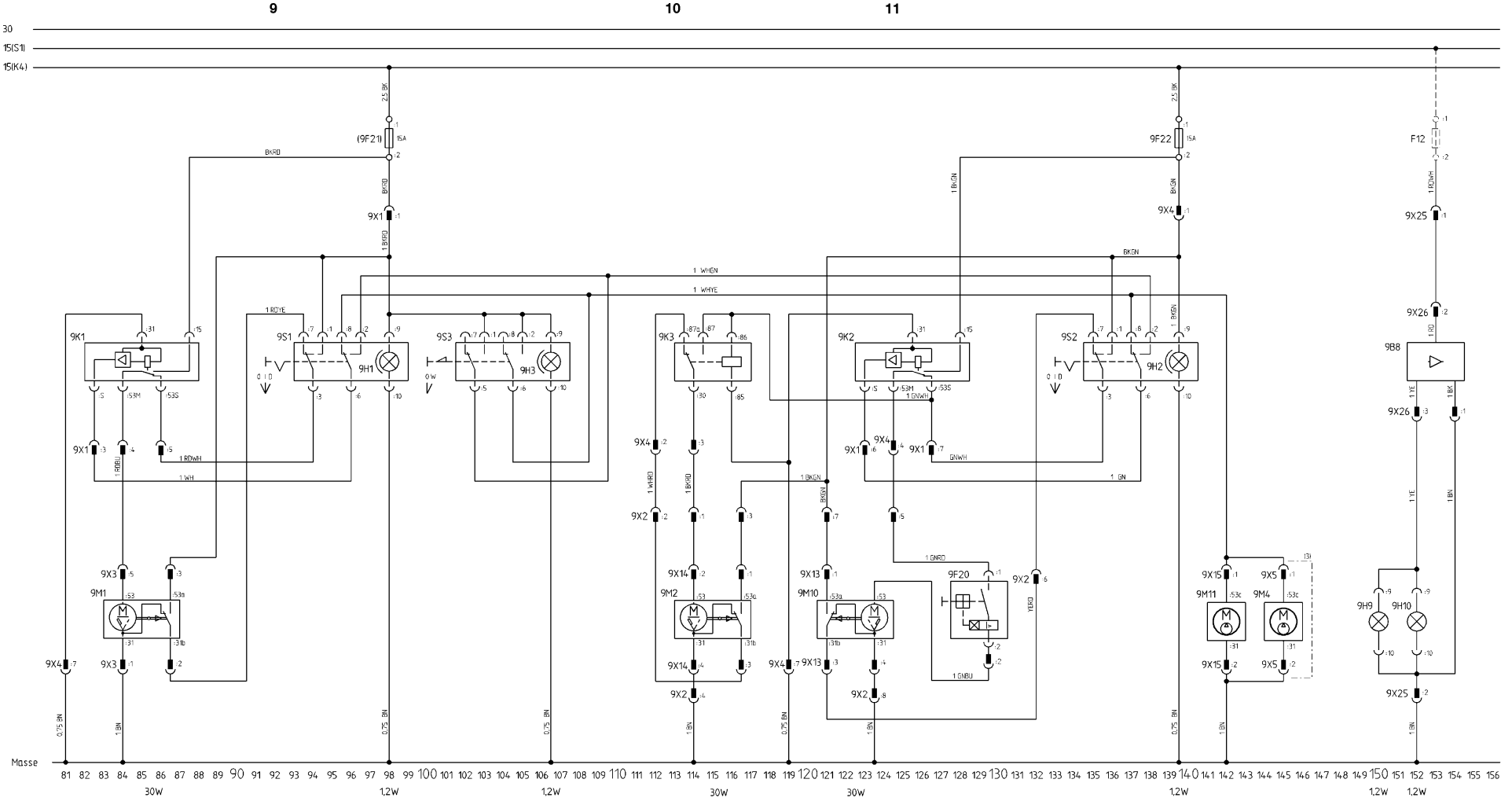
CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80 -03, TYPE 353 DIESEL



35306-12
353 802 6008 a

Service Training

CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80 -03, TYPE 353 DIESEL



35306-13
353 802 6008 a

4.6.7 ELECTRICAL SYSTEM CIRCUIT DIAGRAM, TYPE 353 -03 LPG

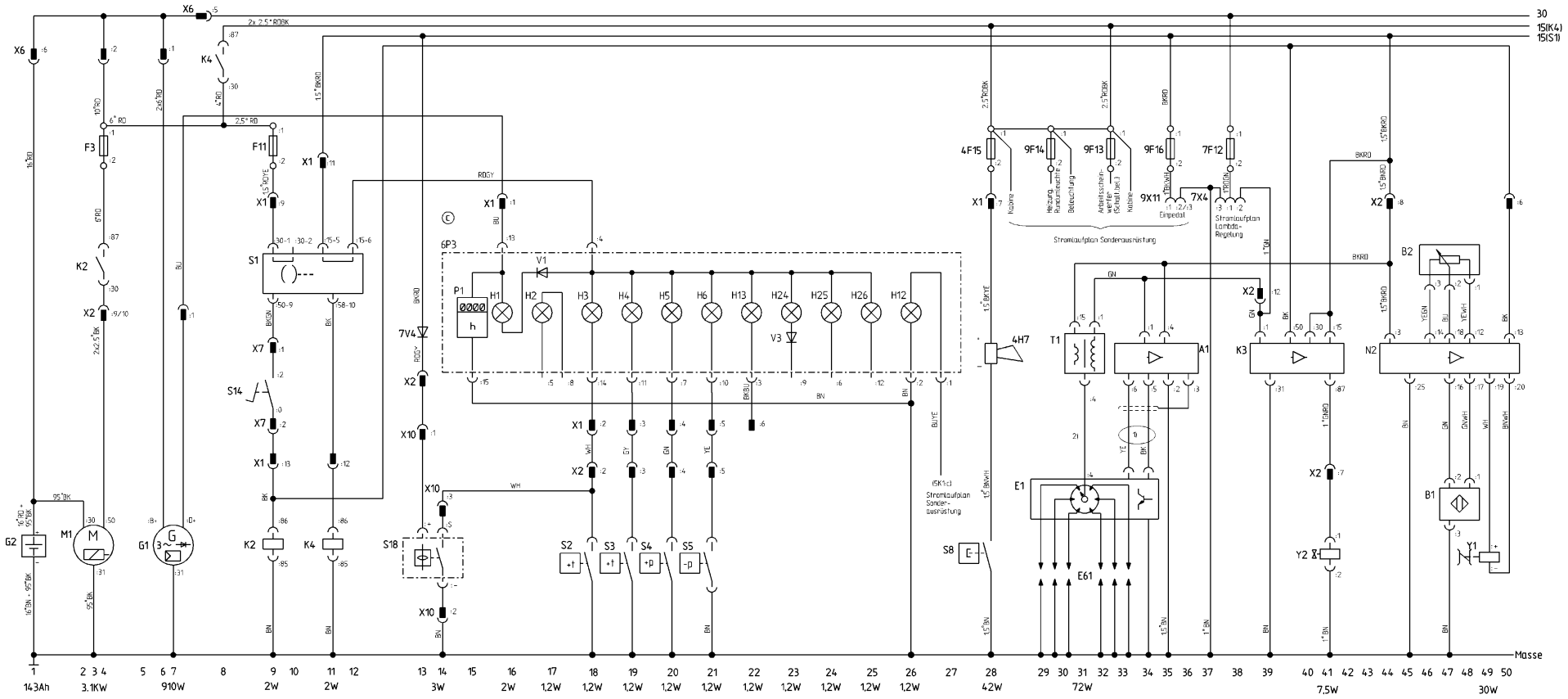
A1	Ignition control device	33-36
B1	Actual speed transmitter	47,48
B2	Set speed transmitter	46-48
E1	Ignition distributor	29-34
E61	Spark plugs	29-33
F3	Fuse 70 A MTA	4
F11	Fuse class 30, S1 10 A	9
4F15	15 A audible warning device fuse	28
7F12	Fuse for Lambda control, 10 A	38
9F13	Fuse for switch illumination of working lights, 5 A	32
9F14	Fuse for heating, 15 A	29
G1	Alternator with regulator	7
G2	Battery	1
H1	Charge indicator	16
H2	Electronic control warning light	17
H3	Engine temperature indicator	18
H4	Hydraulic fluid temperature indicator	19
H5	Oil pressure indicator	20
H6	Suction filter vacuum indicator	21
H12	Turn signal indicator	26
H13	Fuel remaining indicator	22
4H7	Horn	28
K2	Relay for starter motor	3,9
K3	Propellant gas control relay	39-41
K4	Auxiliary relay for terminal 15	8,11
N2	Engine speed regulator	44-50
M1	Starter motor	3
P1	Operating hours counter	15
6P3	Indicator equipment	15-27
S1	Ignition starter switch	9-12
S2	Engine temperature switch	18
S3	Oil temperature switch	19
S4	Oil pressure switch	20
S5	Suction filter vacuum switch	21
S8	Horn button	28
S14	Brake pedal switch	9
S18	Cooling water level sensor	13,14

T1	Ignition coil	30-32
V1/3	Decoupling diodes	17, 23
7V4	Decoupling diode	13
X1	15-pin plug	9-28
X2	12-pin plug	3-22, 39-50
X6	6-pin plug	1,3,7
X7	2-pin plug	9
X10	3-pin plug	13-15
7X4	3-pin plug	38
9X11	3-pin plug	35
Y1	Speed operating magnet	49
Y2	Propellant gas shutoff valve	41

CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	grey
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

CIRCUIT DIAGRAMM H 50/60/70/80 -03, TYPE 353 LPG



35306-14
353 802 0119 c

4.6.8 WIRING DIAGRAM FOR OPTIONS, 353 -03

5E2	Dip beam, right	26
5E3	Dip beam, left	29
5E4	Side light, front right	39
5E5	Side light, front left	31
5E6	Side light, rear left	36
5E7	Side light, rear right	44
5E8	License plate light	46
5E10	Position light, right	41
5E11	Position light, left	34
9E1-9E6	Spotlight	10 - 23
9E9	Seat heating	74
9E13	Interior light	66
5F31,32	Fuses, directional indicators	50, 54
5F33	Fuse, left side lights	31
5F34	Fuse, right side lights	39
5F35	Fuse, left dip beam	29
5F36	Fuse, right dip beam	26
9F13	Fuse for switch illumination working lights	14
9F14	Fuse heater	70
9F16	Fuse, single-pedal model	4, 74
9F20	Fuse for magnetic protective switch	129-131
9F21	Fuse, front windscreen wiper	99
9F22	Fuse, rear / roof windscreen wiper	141
9F23	Fuse for interior lights	66
9F24-26	Fuses, spotlight	12, 19, 21
5H8	Directional indicator, front left	52
5H9	Directional indicator, rear left	49
5H10	Directional indicator, front right	55
5H11	Directional indicator, rear right	57
5H12,13	Switch lighting	33, 55
9H1-9H3	Switch lighting	99, 107, 141
9H5, 9H6	Switch lighting	14, 17
5K1	Direction indicator switch	55 - 57
9K1	Intermittent relay, front wiper	83 - 89
9K2	Intermittent relay, rear/roof wiper	124 - 130
9K3	Rear wiper motor relay	114 - 118
9M1	Wiper motor, front	84 - 88
9M2	Washer, front	144
9M3	Wiper motor, roof	122 - 125
9M4	Wiper motor, rear	114 - 118
9M5	Washer, rear/roof	147
9M6	Fan	70
5S11	Light switch	28 - 34
5S12	Hazard warning light switch	50 - 57

5S13	Directional indicator switch	52 - 55
9S1	Front wiper switch	93 - 99
9S2	Rear/roof wiper switch	135 - 142
9S3	wiper switch, wash	101 - 108
9S5,6	Spotlight switch	11 - 22
9S7	Travel direction switch, single-pedal model	2 - 5
1V11	Free-wheeling diode	6
1V12	Free-wheeling diode	1
5X1	Connector 9 pins	29 - 31, 50 - 60
5X2	Connector 6 pins	26-39,50,58
5X3	Connector 6 pins	36, 44 ,49, 57
5X5	Connector 3 pins	46
5X7	Connector 6 pins	26,39,55
5X8	Connector 6 pins	29,31,52
5X13	Connector 1 pin	60
5X14	Connector 2 pins	34
5X15	Connector 2 pins	41
9X1	Connector 9 pins	70, 84 - 87, 99, 124 - 134, 141
9X2	Connector 6 pins	66, 112 - 126, 134
9X3	Connector 6 pins	85, 87
9X4	Connector 9 pins	112, 115, 125, 134
9X5	Connector 2 pins	147
9X6	Connector 4 pins	12 - 21
9X7	Connector 6 pins	10, 12
9X8	Connector 6 pins	17, 19
9X9	Connector 6 pins	21, 23
9X10	Connector 3 pins	3 - 5
9X11	Connector 3 pins	3 - 5
9X12	Connector 3 pins	3 - 5
9X13	Connector 4 pins	122, 124
9X14	Connector 4 pins	115, 117
9X15	Connector 2 pins	144
1Y1	Solenoid valve, single-pedal model, forward	5
1Y2	Solenoid valve, single-pedal model, reverse	3

CABLE COLOURS

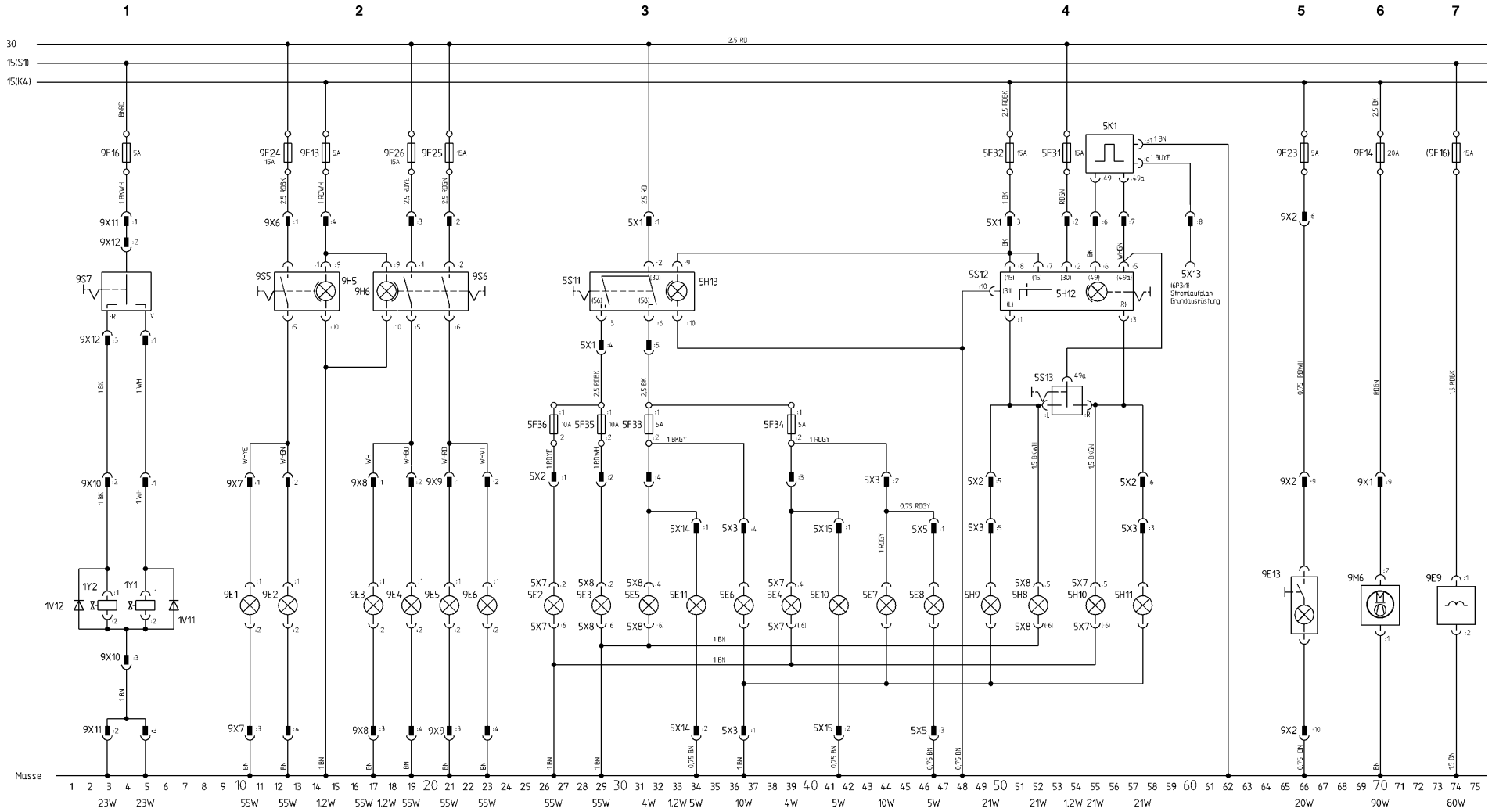
CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	grey
OR	orange
RD	red
YE	yellow
VT	violet

OPTIONS

1	Single-pedal model
2	Spotlight
3	Lighting
4	Directional indicator and hazard warning system
5	Interior light
6	Heater
7	Seat heating
8	Front windscreen wiper
9	Rear windscreen wiper
10	Roof windscreen wiper

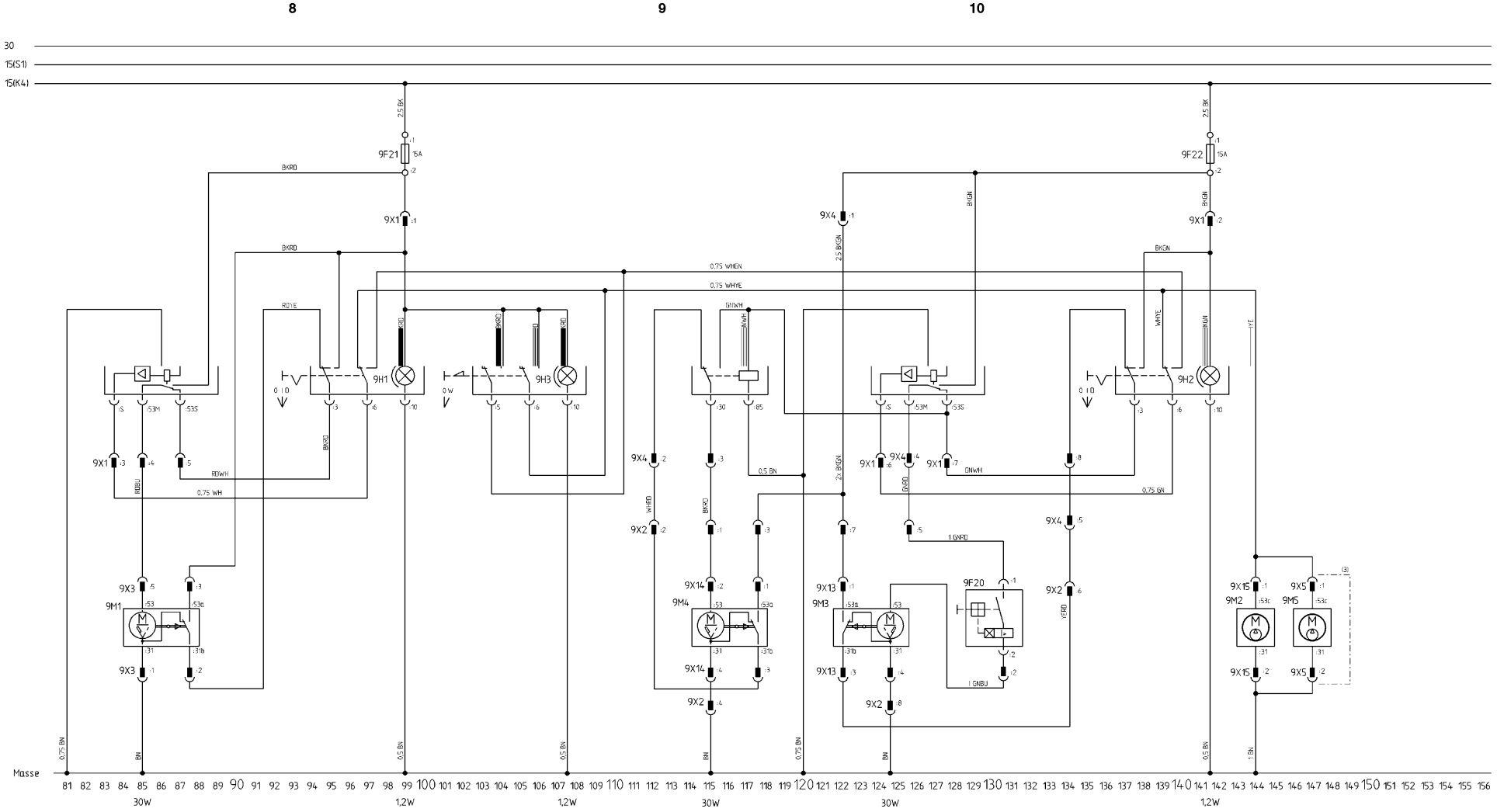
CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80 -03, TYPE 353 LPG



35306-15
353 802 6009

Service Training

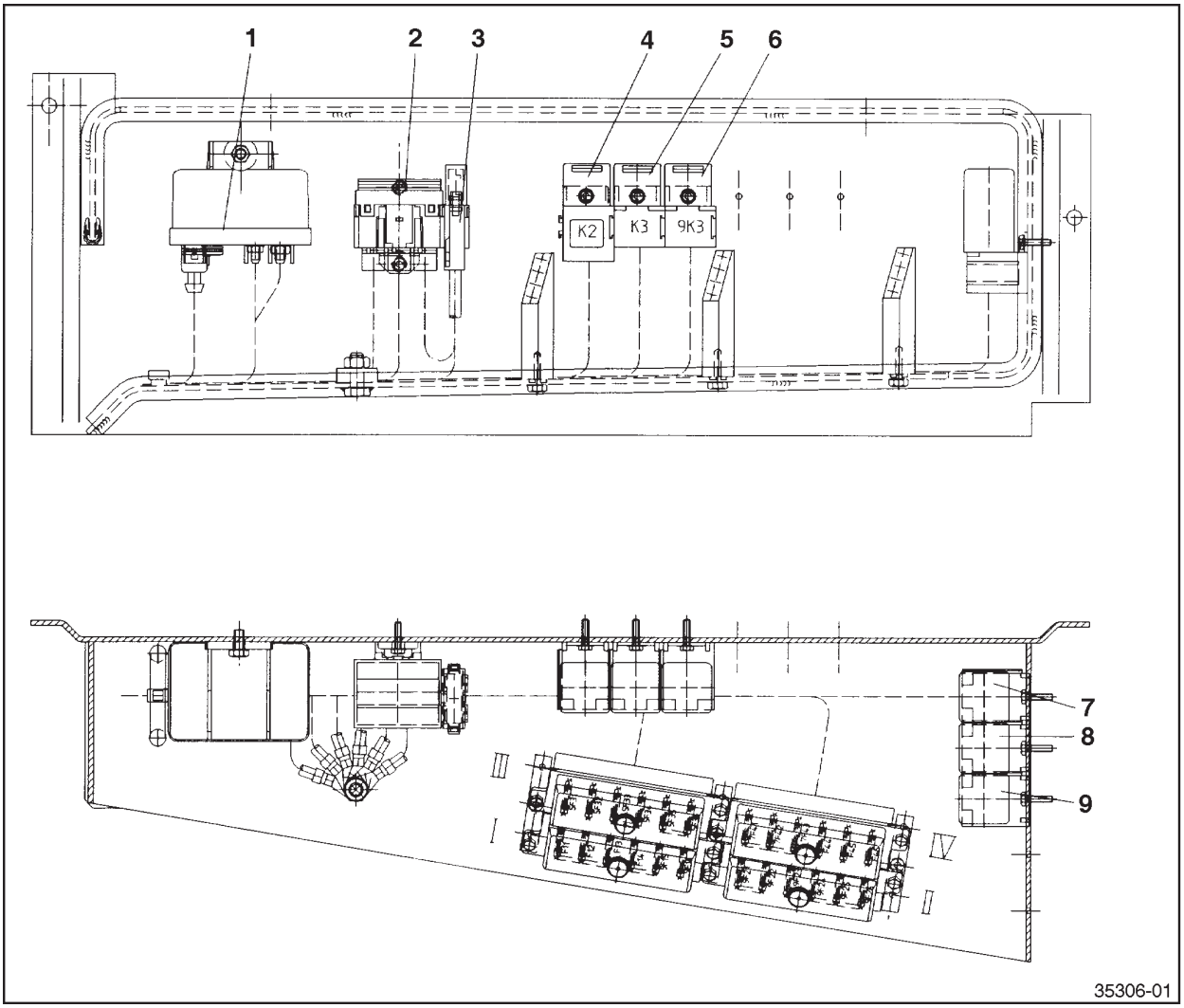
CIRCUIT DIAGRAMM FOR OPTIONAL EQUIPMENT H 50/60/70/80 -03, TYPE 353 LPG



35306-16
353 802 6009

4.6.9 CENTRAL ELECTRICAL SYSTEM

The whole electrical system ist mounted on the left side of the truck behind a cover of the second foothold.

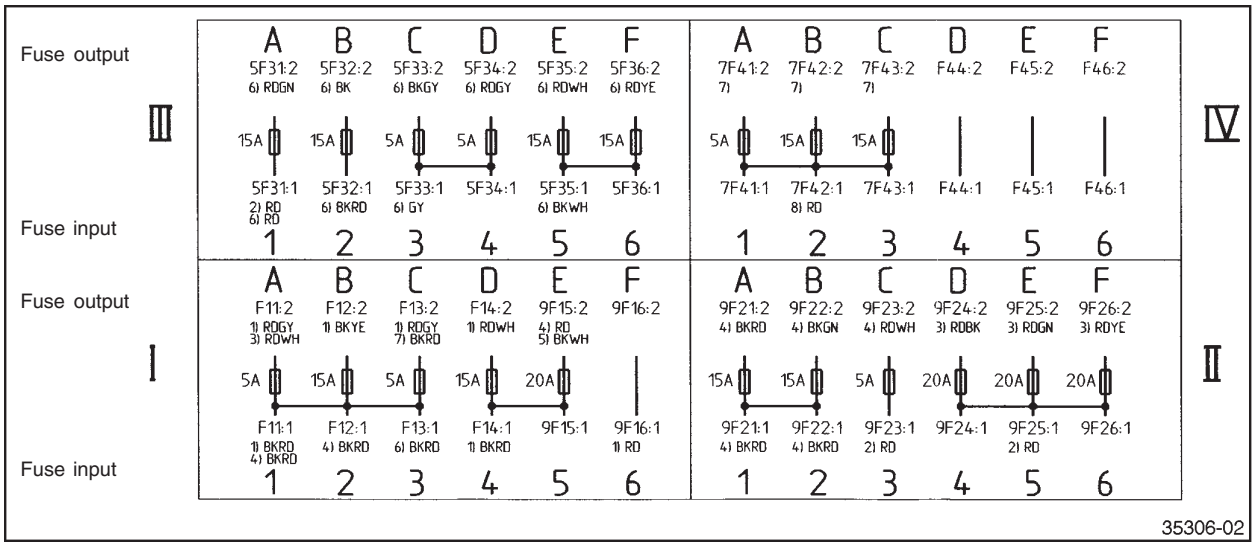


1 Preheating relay
2 Distributor plug (plus)
3 Preheating fuse 80 A
4 Starter relay
5 Signal converter preheating
6 Windsccreen wiper relay
7 Interval relay 9K1
8 Interval relay 9K2
9 Flasher relay 5K1

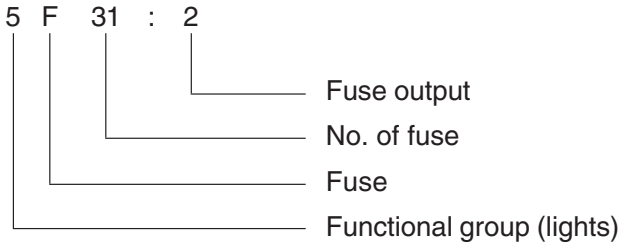
I Fuse box
II Fuse box
III Fuse box
IV Fuse box

TOP VIEW OF FUSE BOXES I - IV

The fuse box I ist standard version, the boxes II, III and IV are fitted depending on the special equipment.

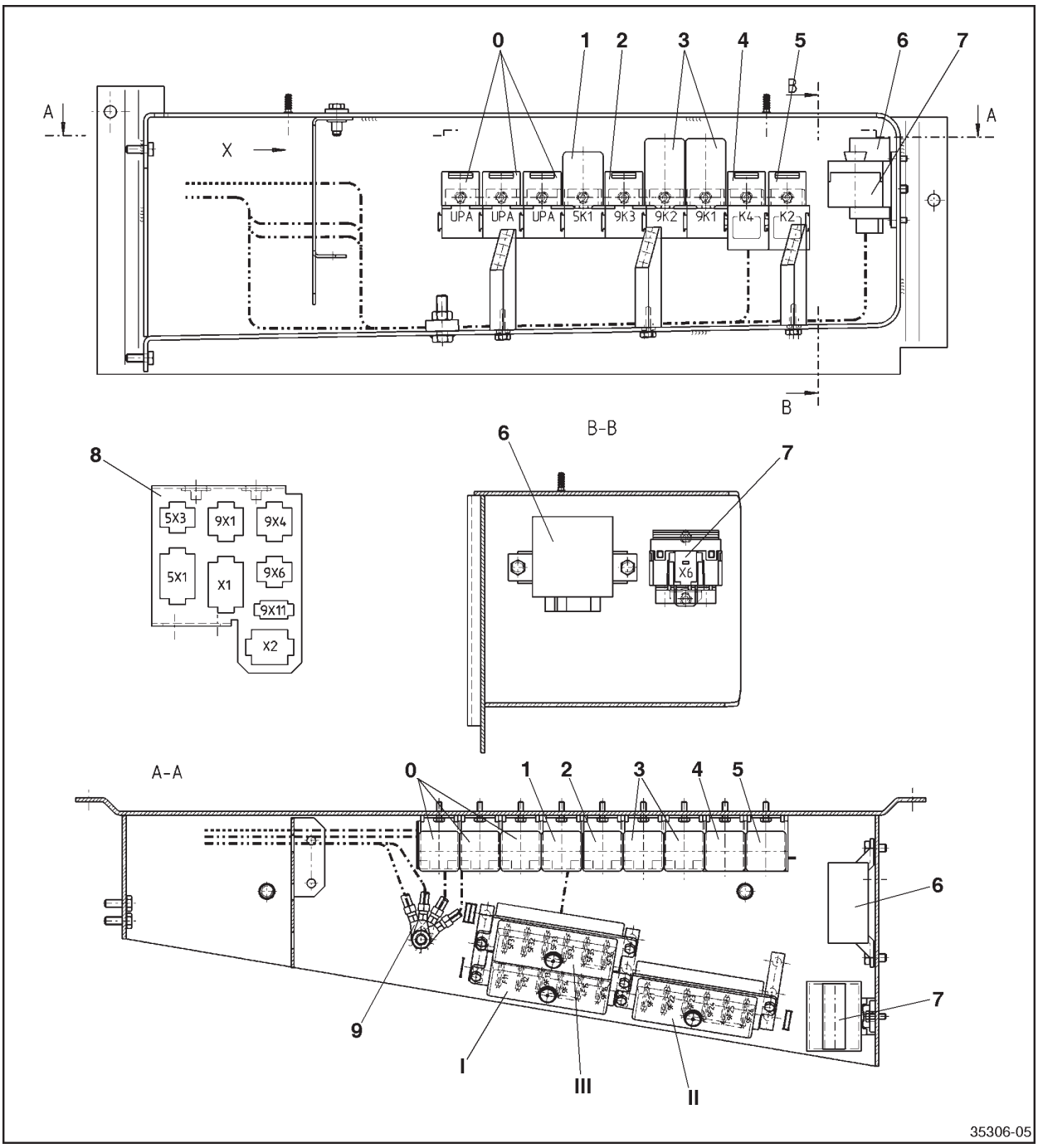


EXAMPLE FOR A FUSE APPLICATION



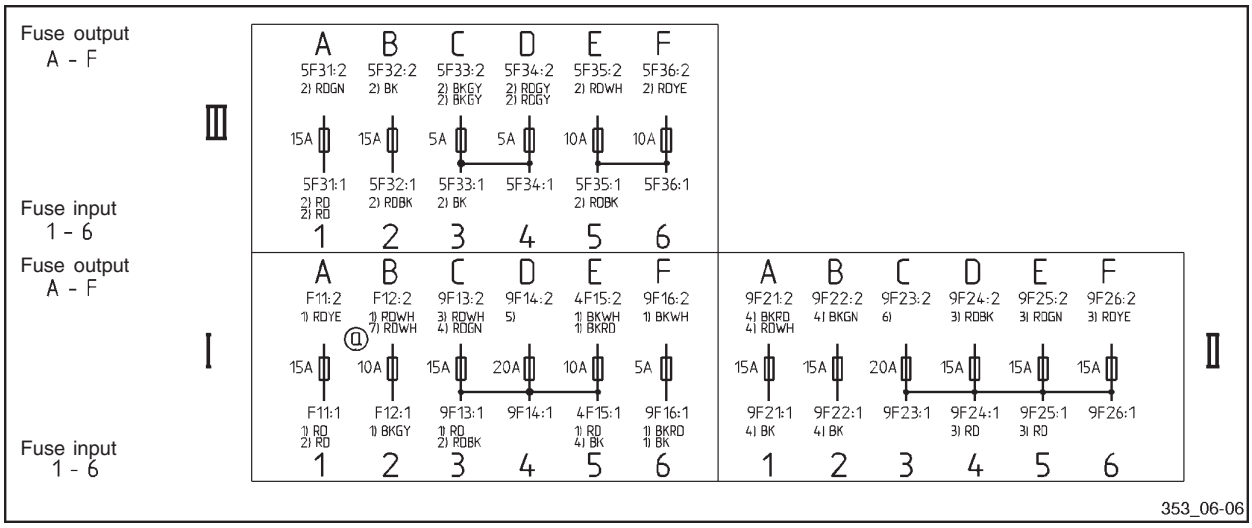
4.6.10 CENTRAL ELECTRICS OF SERIES 353 -03

4.6.10.1 RELAY AND FUSES OF 353 -03 DIESEL



0 Relay for UPA
1 Indicator relay 5K1
2 Wiper relay 9K3
3 Interval relay 9K1/9K2
4 Relay K4 load relay
5 Starter relay K2
6 Control device for heater flange A1
7 Plus distributor
8 Plug for interfaces
9 Minus distributor

TOP VIEW OF FUSE BOXES I - III



Fuse box I

1	Ignition starter, display (F11)	15 A
2	Supply of glow time control device (F12)	10 A
3	Switch illumination, heating* (9F13)	15 A
4	Seat heating* (9F14)	20 A
5	Horn (4F15)	10 A
6	Single-pedal model* (9F16	5 A

Fuse box II

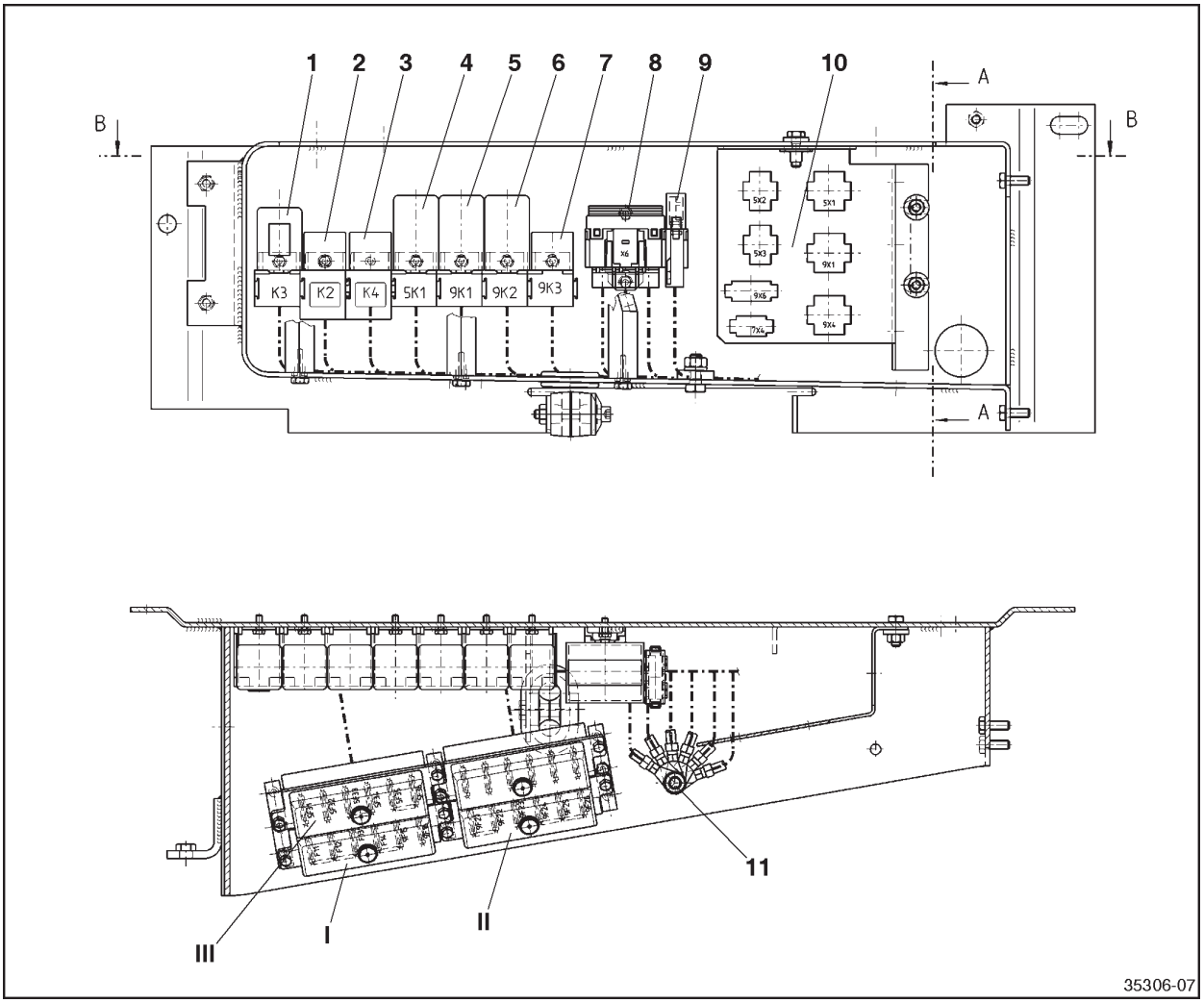
1	Front wiper*, Interior lights (9F21)	15 A
2	Windscreen wiper*, rear, roof (9F22)	15 A
3	Spare fuse* (9F23)	20 A
4	Working light* (9F24)	15 A
5	Working light* (9F25)	15 A
6	Working light* (9F26)	15 A

Fuse box III

1	Turn-signal system* (5F31)	15 A
2	Turn-signal system* (5F32)	15 A
3	Side marker* left side(5F33)	5 A
4	Side marker* right side (5F34)	5 A
5	Dip beam* left (5F35)	10 A
6	Dip beam* right (5F36)	10 A

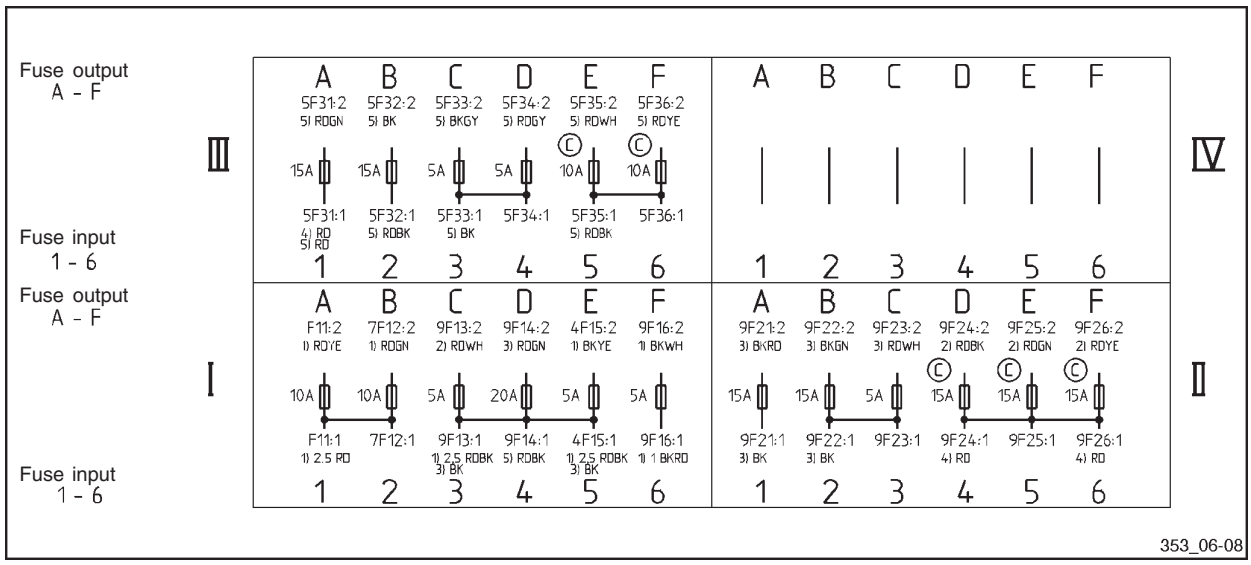
* Optional equipment

4.6.10.2 RELAY AND FUSES OF 353 -03 LPG



1 Relay K3 for LPG cut-off
2 Relay K2 for starter
3 Relay K4 load relay
4 Indicator relay 5K1
5 Relay 9K1 for interval
6 Relay 9K2 for interval
7 Relay 9K3 for wiper
8 Relay for plus distributor
9 Fuse 70 A MTA
10 Plug connector 5X1/5X2/5X3/9X1/9X6/7X4/9X4
11 Minus distributor

TOP VIEW OF FUSE BOXES I - IV



Fuse box I

1	Indicating device, ignition starter switch (F11)	10 A
2	Catalyst* (7F12)	10 A
3	Switch illumination for working lights* (9F13)	5 A
4	Heating*, revolving light* (9F14)	20 A
5	Horn (4F15)	5 A
6	Single pedal model* (9F16)	5 A

Fuse box II

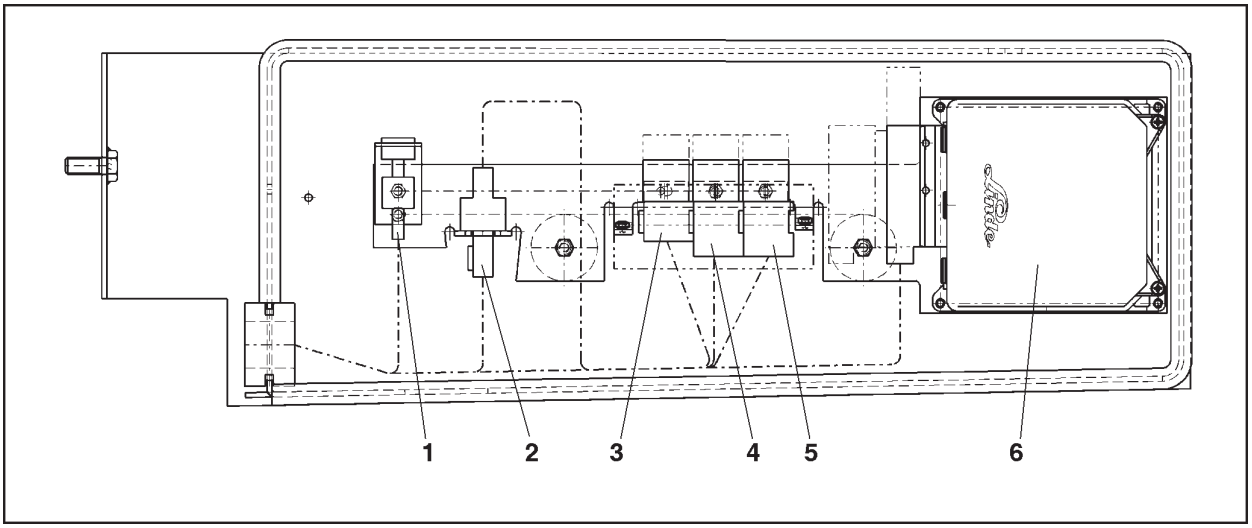
1	Windscreen wiper* front 9F21)	15 A
2	Windscreen wiper* rear, roof (9F22)	15 A
3	Interior light* (9F23)	5 A
4	Working light* (9F24)	15 A
5	Working light* (9F25)	15 A
6	Working light* (9F26)	15 A

Fuse box III

1	Turn-signal system* (5F31)	15 A
2	Turn-signal system* (5F32)	15 A
3	Side marker* left side (5F33)	5 A
4	Side marker* right side (5F34)	5 A
5	Dip beam* left side (5F35)	10 A
6	Dip beam* right side(5F36)	10 A

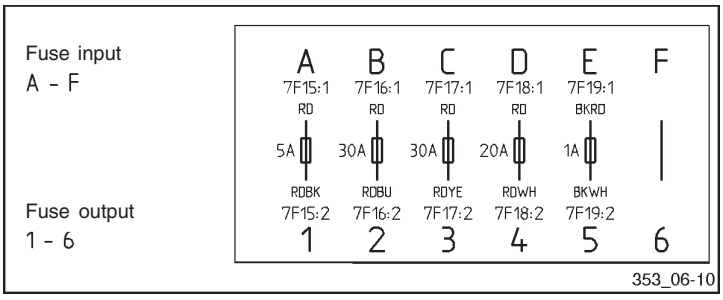
* Optional equipment

4.6.10.3 RELAY AND FUSES FOR 353 -03 PARTICULATE TRAP



1 Diagnostic plug 6X8
2 Signal transmission connector 7X9
3 Relay 7K12, 12V/20 A
4 Relay 7K9, 12 V/70 A
5 Relay 7K11, 12 V/70 A
6 Control device for particulate trap 7A1

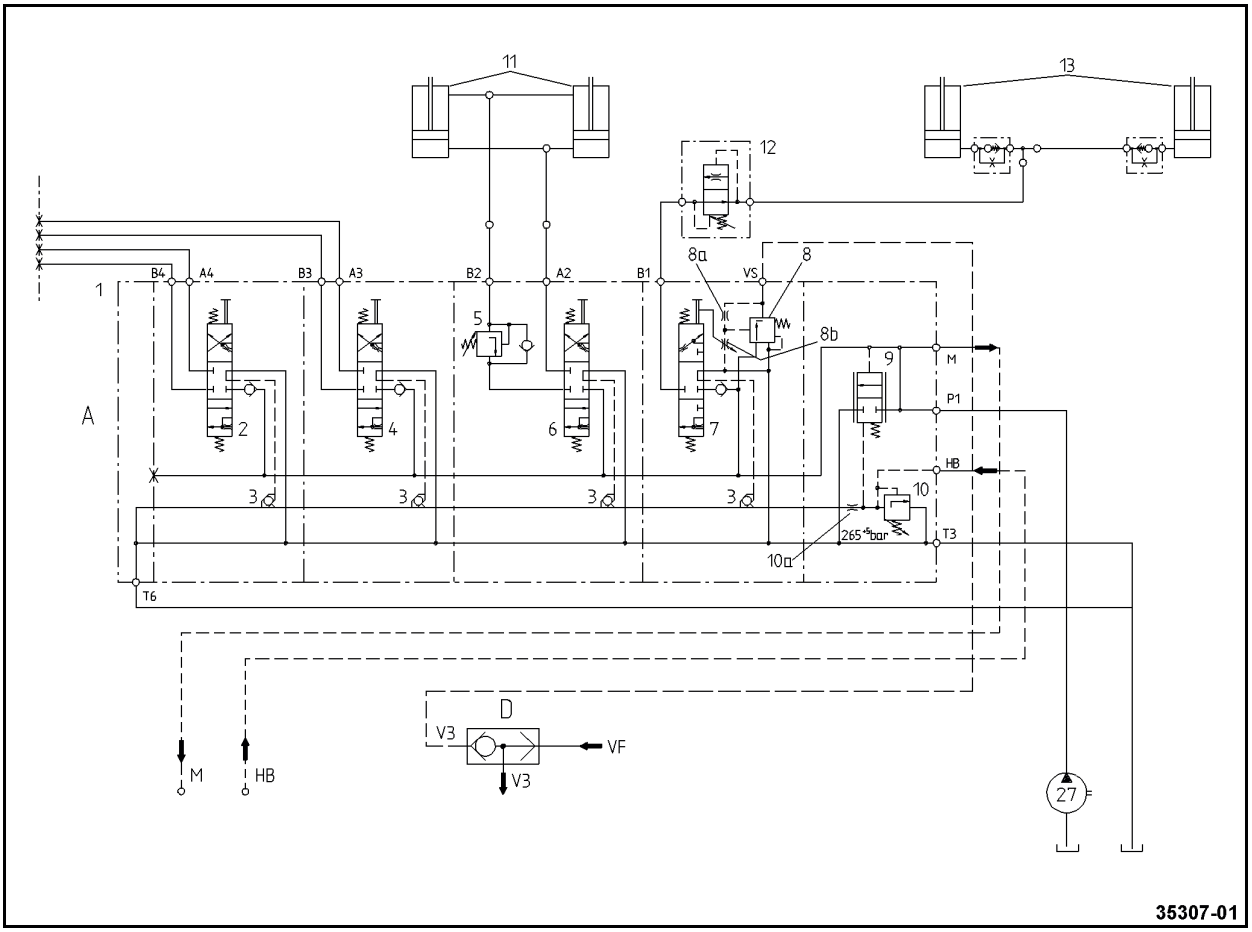
TOP VIEW OF FUSE BOXES


Fuse input
A - F
Fuse output
1 - 6
A B C D E F
7F15:1 7F16:1 7F17:1 7F18:1 7F19:1
RD RD RD RD BKRD
5A 30A 30A 20A 1A
RDBK RDBU RDYE RDWH BKWH
7F15:2 7F16:2 7F17:2 7F18:2 7F19:2
1 2 3 4 5 6
353_06-10

1 Fuse 7F15, 5A
2 Fuse 7F16, 30 A
3 Fuse 7F17
4 Fuse 7F18
5 Fuse 7F19

4.7 WORKING HYDRAULICS

4.7.1 WORKING HYDRAULICS CIRCUIT DIAGRAM



1 Control valve assembly consisting of:
2 Way valve (auxiliary hydraulics)
3 Shuttle valve
4 Way valve (auxiliary hydraulics)
5 Pressure holding valve
6 Way valve - tilting
7 Way valve - lifting
8a Restrictor
8b Restrictor
9 2/2-way valve (pressure balance)
10 Maximum pressure valve, 265 bar
11 Tilt cylinder
12 Slow down valve
13 Lift cylinder
27 Axial piston pump MPF 55

D Shuttle valve

4.7.1.1 EXPLANATION OF THE WORKING HYDRAULICS

When the control levers are in the neutral position and the pump output is nill, way valves (2), (4), (6) and (7) and also the pressure balance (9) are closed. Port P1 is connected via the pressure-reducing valve (8) to port VS.

When the engine is running, oil coming from the pump (27) enters the valve block at port P1 and opens the pressure balance (9) against the force of the spring, thus making the oil circuit pressureless. The spring pressure exerted on the pressure balance and the pressure applied at port P1 are in balance with a differential pressure of approx. 5 bar. The oil pressure existing at port M goes to inlet M of the emergency valve, while port HB is connected to outlet HB of the emergency valve.

Operating one of the control levers lets the load pressure go through a special control oil passage in the control spool of the way valve in question and via the shuttle valves (3) and restrictor (10a) to the shock valve (10) and into the spring chamber of the pressure balance (9). Due to the change in the balance of pressure, the pressure balance closes just enough so that oil flows through the way valve to the load. The volume of the oil flow depends on how far the way valve spool is shifted. The pressure balance lets the excess oil go directly to port T3.

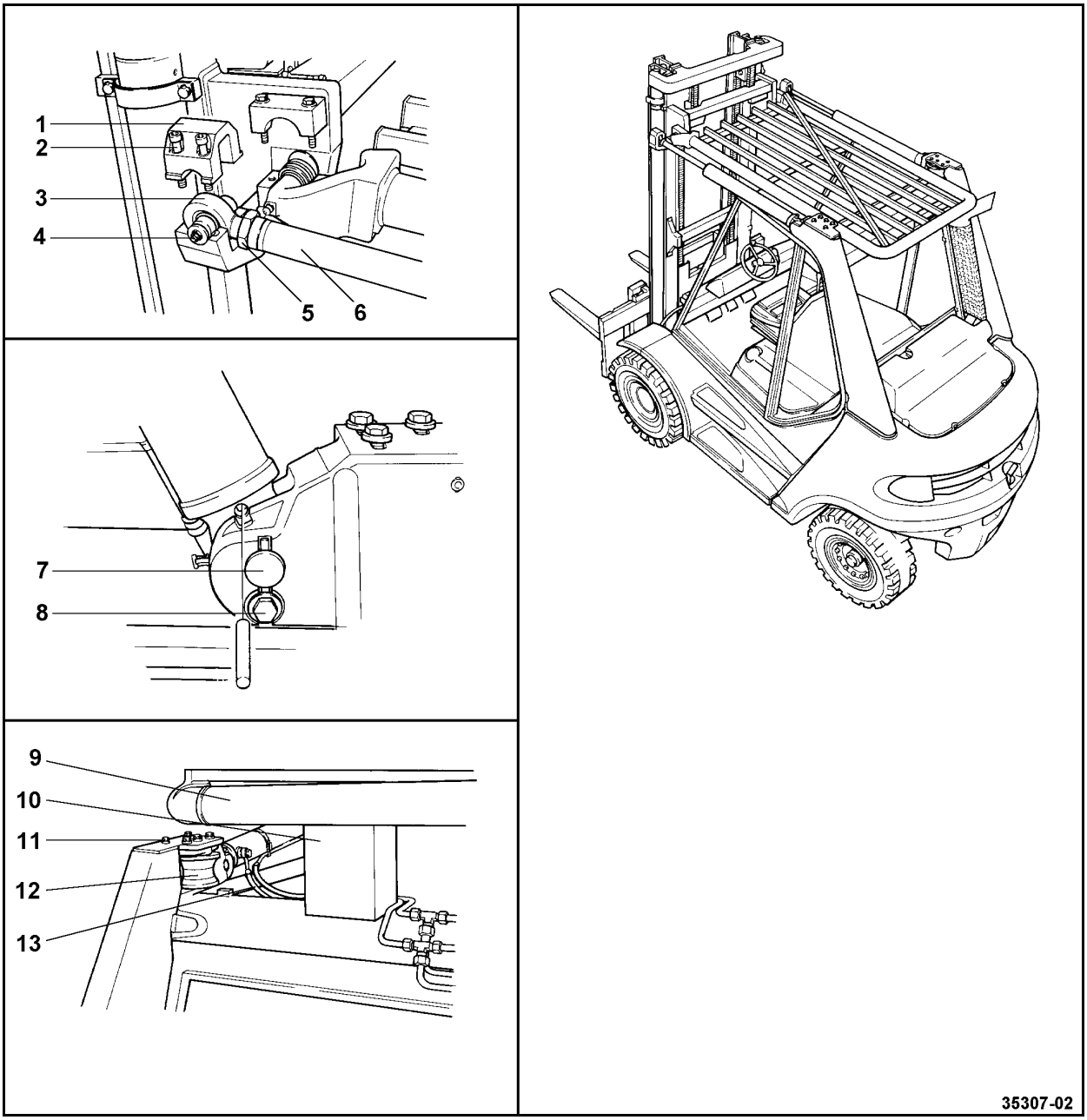
When the set pressure of the safety valve (10) is reached, the maximum pressure valve opens and lets oil flow to port T3. Due to the differential pressure resulting at restrictor (10a), the load pressure becomes greater than the response pressure of the maximum pressure valve and the pressure balance is modulated so that only so much oil flows as is required for the maintenance of the differential pressure at restrictor (10a). Any excess oil is diverted to port T3 by the pressure balance (10).

SPEED CONTROL

The inlet of the pressure-reducing valve (8) is connected to oil passage P1 and the outlet to the engine speed control unit via port VS. The actual value signal is connected to the tank via the restrictor passage (8a)-(8b). When the valve spool for lifting is not operated, restrictor (8b) is closed. The actual value for the pressure-reducing valve is therefore taken between restrictors (8b) and (8a). When the way valve for tilting (6) or auxiliary hydraulics (2) or (4) is activated, the pressure-reducing valve lowers the pressure on the outlet side to approx. 7 bar, letting the engine speed rise to approx. 1200 rpm.

When the way valve (7) for lifting is operated, restrictor (8b) is opened more and more, depending on the setting of spool (7), and thus connecting it to the tank. This creates a differential pressure, whose size depends on the setting of spool (7), between the signal for increasing speed and the actual value pick-up. The engine control pressure will increase so much that the engine will accelerate to top speed. As no pressure builds at port P1 during lowering, the engine speed is not increased then.

4.7.2 TILT CYLINDER



1 Bearing bracket
2 Screw
3 Eyebolt
4 Bearing pin
5 Locknut
6 Piston rod
7 Rear bearing pin
8 Retaining screw
9 Overhead guard
10 Support
11 Screw
12 Roller mount with roller
13 Hoses

4.7.2.1 TILT CYLINDER REMOVAL, INSTALLATION, ADJUSTMENT, SEALING

TILT CYLINDER REMOVAL

- Tilt the mast forward as far as possible.
- Unscrew and remove the bearing bracket (1) on the cross member of the outer upright.
- Press the piston rod (6) and pin (4) up and out of the lower bearing half, but leave it in the bearing.
- Slacken the fastening screws (11) on the left and right roller mount (12) and slide outward.
- Lift the overhead guard approx. 30 cm and block it with a support (10).
- Disconnect the tilt cylinder hoses (13).
- Remove the retaining screw (8) for the pin (7) and drive the pin (7) out from the inside.
- Lift off the cylinder assembly.

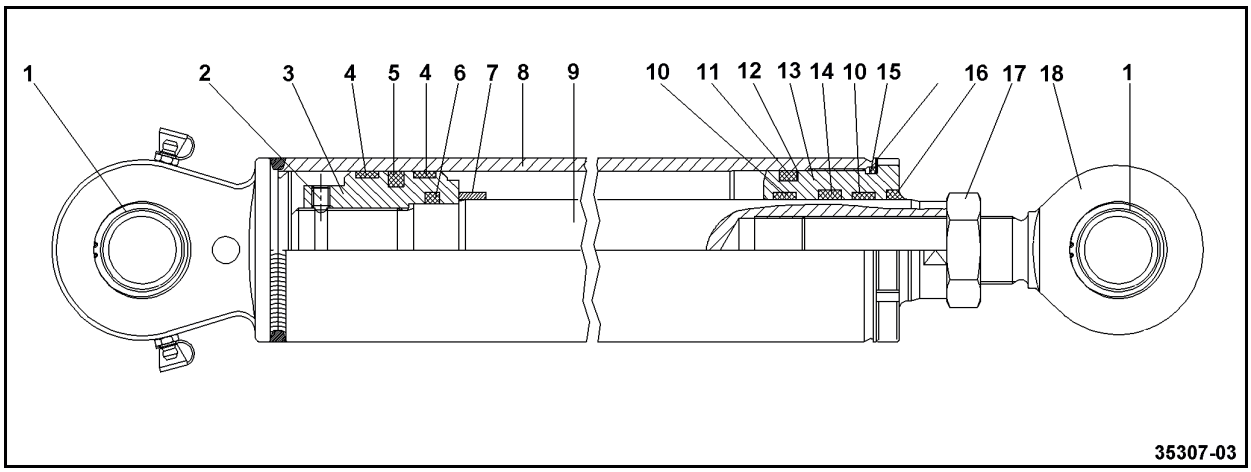
TILT CYLINDER INSTALLATION

- Insert the tilt cylinder along with the pin (4) fitted in the eyebolt (3) into the front bearing half.
- Align the cylinder barrel eyebolt with the hole of the rear pivot, install the pin (7) and tighten the retaining screw (8).
- Connect the hoses (13).
- Install the front bearing bracket (1) and tighten the screws (2) to 46 Nm.
- Re-install the overhead guard correctly.

TILT CYLINDER ADJUSTMENT

- Tilt the mast forward as far as possible.
- After slackening the locknut (5), turn the piston rod so that both pistons are at their mechanical stop without twisting the mast.
- Check the mast angle of tilt and, if necessary, turn both pistons outward or inward as required.
- Lock the locknut (5).

SEALING THE TILT CYLINDER



1 Bearing
2 Setscrew
3 Piston
4 Guide ring
5 Piston seal
6 Rod seal
7 Bushing - piston stroke limiter
8 Cylinder barrel
9 Piston rod
10 Guide ring
11 Sealing ring
12 Support ring
13 Cylinder head
14 Rod seal
15 O-ring
16 Wiper
17 Hexagonal nut
18 Eyebolt

SEALING THE PISTON ROD

Condition: Cylinder removed

- Clamp the cylinder with the eyebolt of the cylinder barrel (8) in a vise.
- Unscrew the hexagonal nut (17) while holding the piston rod with a 41 mm flat spanner and remove the eyebolt (18) from the piston rod (9).
- Open the flanged retainer for the cylinder head (13).
- Screw the cylinder head (13) out of the barrel (8) with a suitable hook spanner.
- Inspect the piston rod for damage.
- Remove the cylinder head seals and clean the cylinder head.
- Install new cylinder head seals.
- Grease the seals slightly, slide the cylinder head on the piston rod, screw into the barrel and tighten to 300 - 350 Nm, drive in the flanged retainer.
- Screw the eyebolt (18) with nut (17) back into the piston rod.
- Re-assemble the cylinder and adjust the eyebolt (18) according to the adjustment procedures and lock it with the nut.

RENEWING THE PISTON SEALS

Condition: Cylinder removed

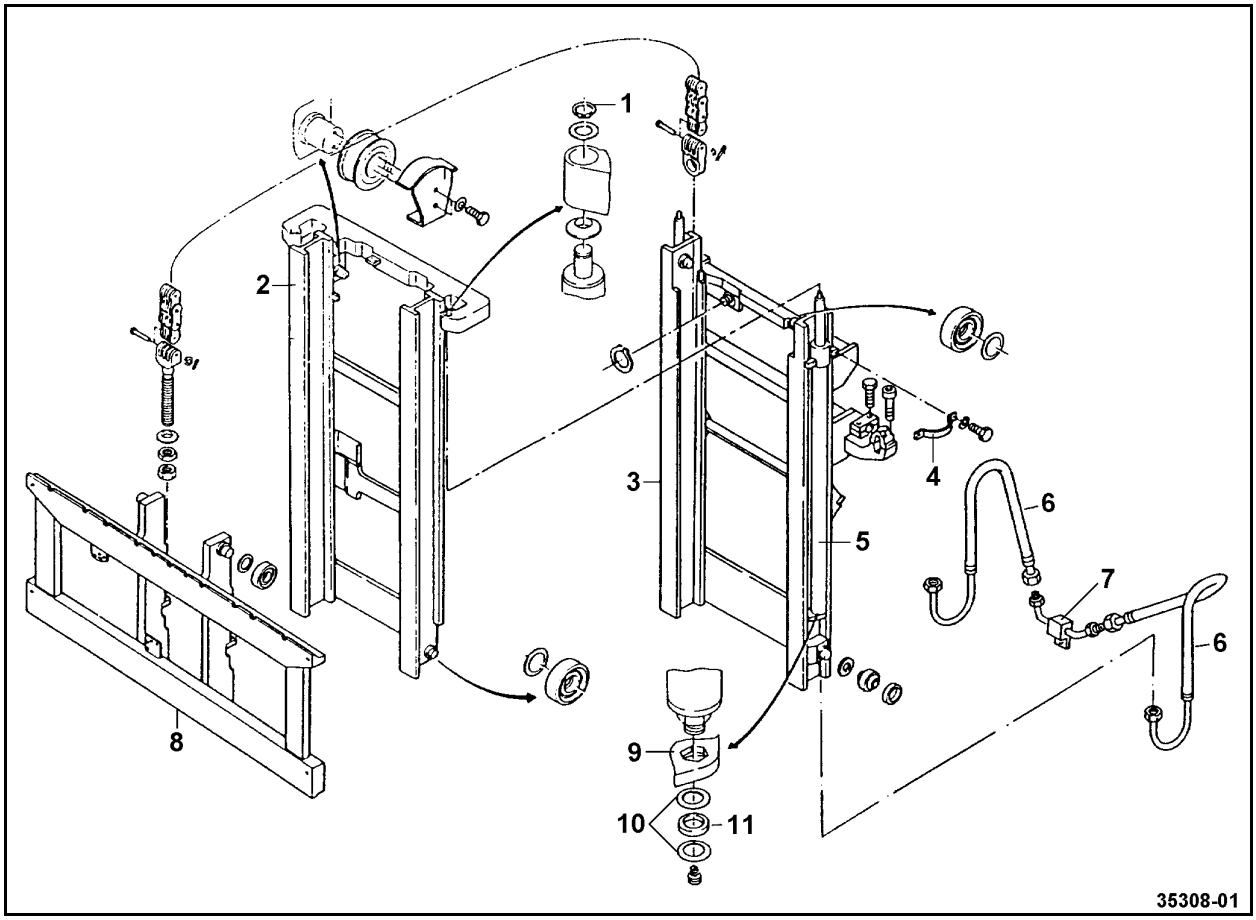
- Clamp the cylinder with the eyebolt of the cylinder barrel (8) in a vise.
- Open the flanged retainer for the cylinder head (13) and screw the cylinder head out of the barrel.
- Pull the piston rod assembly out of the barrel.
- Remove the setscrew (2).
- Screw the piston (3) off the piston rod.
- Remove the seals.
- Thoroughly clean the inside of the piston and cylinder barrel and inspect for damage.
- Install new seals.
- Screw the piston onto the piston rod and torque to 500 - 550 Nm. Secure the piston with the setscrew (2).
- Grease the seals slightly and insert the piston rod and piston into the cylinder barrel.
- Screw in the cylinder head (13), tighten as specified and secure it.
- Mount the cylinder and adjust according to the adjustment procedures.

Service Training

4.8 MAST

4.8.1 MAST REMOVAL

- Remove the forks.
- Lower the fork carriage.
- Tilt the mast fully forward.
- Disconnect the hoses (6) on the fitting (7).
- Unscrew the overhead guard bearings on the left and right and slide the overhead guard back.
- Remove the left and right tilt cylinder pivots, tilt the cylinder up and secure it.
- Attach a rope to the top cross member of the outer upright and hook on a crane. Be sure that the load capacity of the crane and rope is sufficient.
- Remove the mast pivot bearing pillows and lift the mast out of the pivots.
- Installation is the reverse of removal.
- Bleed the lift cylinders when taking the truck into operation again.

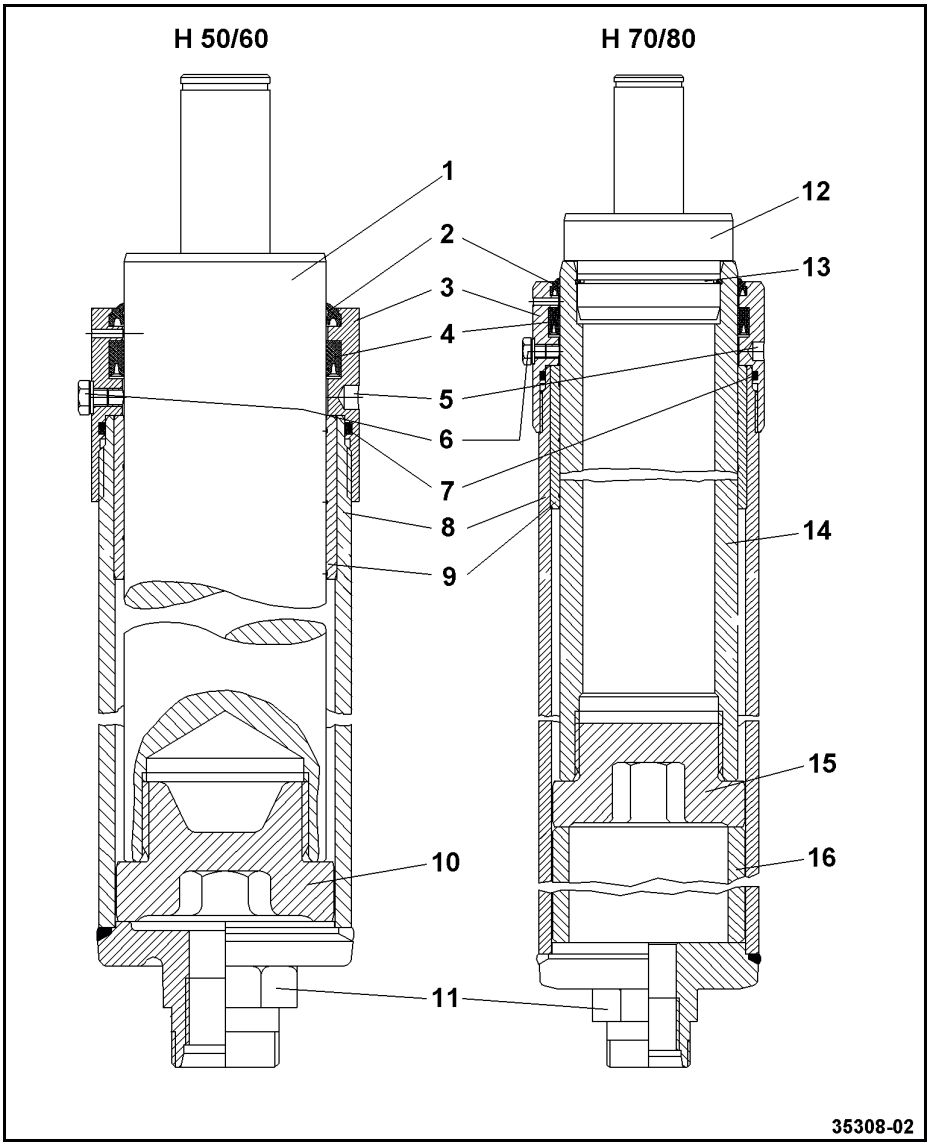


1 Retaining ring
2 Inner upright
3 Outer upright
4 Bracket
5 Lift cylinder
6 Hoses
7 Fitting
8 Fork carriage
9 Cylinder mount
10 Washers
11 Washer

4.8.2 LIFT CYLINDER REMOVAL, INSTALLATION

- Start the engine, operate the lift hydraulics and raise the fork carriage (8) approx. 1 metre.
- Pry out the retaining ring (1) of the cylinder to be removed.
- Block up the inner upright (2), operate the lowering control lever until the inner upright is supported by the block and continue to operate the lever until the piston rod of the cylinder to be removed is fully lowered.
- Disconnect the hose (6) at the base of the cylinder.
- Remove the bracket (4) on the outer upright (3).
- Tilt the cylinder (5) slightly to the side, sling a rope around the cylinder and lift the cylinder out of the mount (9) with a suitable hoist (crane or fork truck).
- Installation is the reverse of removal.
- Bleed the cylinder when taking the truck into operation.

4.8.3 SEALING THE LIFT CYLINDER



1 Piston rod diam. 68 - H 50/60 only
2 Wiper
3 Cylinder head
4 Grooved ring
5 Opening for socket spanner
6 Bleed screw
7 O-ring
8 Cylinder barrel
9 Guide bushing
10 Stop screw
11 Hexagon head 42 mm

H 70/80, DEVIATION FROM H 50/60

12 Piston head with tang (top piston head)
13 Retaining ring
14 Piston rod - tube diam. 77 mm
15 Stop screw - bottom piston head
16 Bottom stop sleeve

SEALING THE H 50/60/70/80 LIFT CYLINDER

Condition: Cylinder removed

- Hold the cylinder at the 42 mm hexagon head (11).
- Slightly heat the cylinder head (3) in the area of the thread and unscrew from the cylinder barrel (8) with a suitable socket spanner.
- Pull the piston rod (1) or (14) out of the barrel (8) and inspect for damage.
- Remove the cylinder head seals (3).
- Clean the cylinder head and install a new seal kit consisting of: O-ring (7), grooved ring (4) and wiper (2).
- Insert the piston rod into the cylinder barrel.
- Coat the cylinder head thread with Loctite No. 270 and screw it onto the clean thread of the cylinder barrel.
- Install the lift cylinder on the mast and eliminate any air in the cylinder when taking into operation.

REMARK: H 70/60 ONLY

The H 70/80 piston rod (14) consists of a barrel with a piston head (12) installed at the top end and made into a single unit with the retaining ring (13).

If oil leaks at the top piston head (12), the lower piston head (15) is not tight and must be dismantled, cleaned and re-installed using Loctite No. 243.

Service Training

4.9 LP GAS MODEL H 50/60/70/0,TYPE 353

4.9.1 DRIVE ENGINE

4.9.1.1 TECHNICAL DATA ON ENGINE

4.9.1.1.1 TECHNICAL DATA ON ENGINE UP TO 12/2004

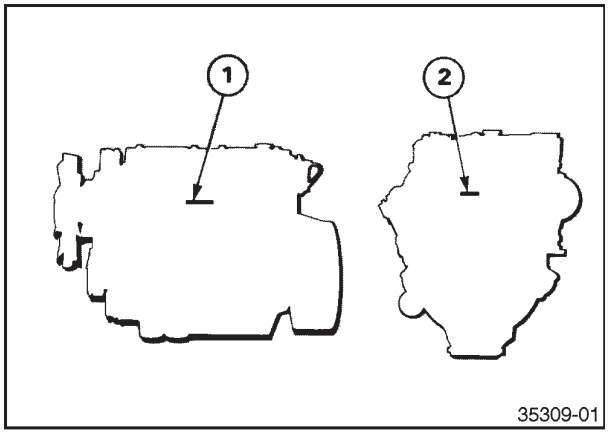
Engine type	Perkins 1006.6 T
List of components	YF 80929
Power	72 kW
Compression	rating: 13 bar wear limit: 10 bar
Max. admissible pressure difference	2 bar
Rated speed	2100 rpm
Idling speed	800 rpm
Max. running torque	355 Nm / 1250 rpm
Ignition timing	18 ± 2 ° before TDC at 800 rpm
Cylinder 1	Cylinder gear side
Firing sequence	1 - 5 - 3 - 6 - 2 - 4
Spark plug	Champion C6 BYC
Speed-limiting device	3200 rpm
Valve clearance (cold)	Intake 0.20 ± 0.05 mm Outlet 0.45 ± 0.05 mm
Coolant	Water
Thermostat	Wax
Opening temperature	80 °C
Opening completely open	98 °C

4.9.1.1.2 TECHNICAL DATA ON ENGINE FROM 01/2005

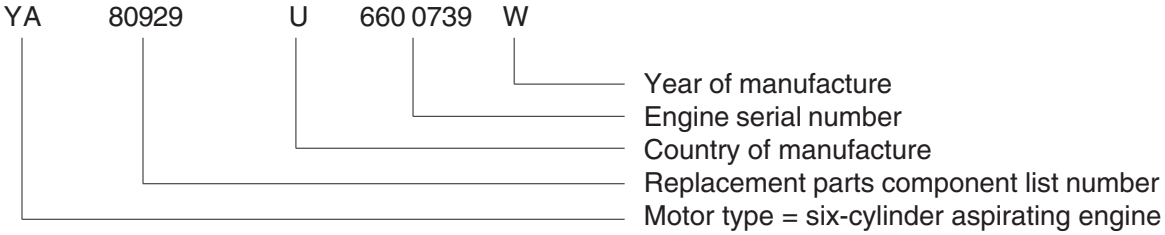
Engine type	Perkins KVT 1000.6 EGSIT
List of components	YF 80929
Power	72 kW
Compression	rating: 13 bar wear limit: 10 bar
Max. admissible pressure difference	2 bar
Rated speed	2100 rpm
Idling speed	800 rpm
Max. running torque	355 Nm / 1250 rpm
Ignition timing	18 ± 2 ° before TDC at 800 rpm
Cylinder 1	Cylinder gear side
Firing sequence	1 - 5 - 3 - 6 - 2 - 4
Spark plug	Bosch FR 56
Speed-limiting device	3200 rpm
Valve clearance (cold)	Intake 0.20 ± 0.05 mm
	Outlet 0.45 ± 0.05 mm
Coolant	Water
Thermostat	Wax
Opening temperature	80 °C
Opening completely open	98 °C

4.9.1.2 NOTE ON THE ENGINE NUMBER

The engine number is printed on a plate, which is affixed to the side of the injection pump (1) or at the back, on the cylinder block (2).



BREAKDOWN OF THE ENGINE NUMBER



If you require replacement parts, service or information on your engine, you will need to quote the full motor number to your Perkins representative

4.9.1.3 CHANGING AND TENSING V-BELT

CHANGING THE V-BELT

- Remove cover (1) on the rear panel.
- Open engine cover
- Loosen hexagon nut (3) on adjusting rail.
- Loosen fixing screw (4).
- Press alternator (5) against the engine.
- Turn support with LP gas tanks towards the back on the side.
- Remove the cover on the counterweight.
- Unscrew screws (6 of them) from counterweight on radiator cover.
- Remove cover plate (8) upwards from radiator.
- Unscrew fastening screws of the fan from top and remove radiator by pulling it out towards the fan.
- In this position, the V-belts can be removed.

NOTE: Only change V-belts in pairs.

- Fit new V-belts and fasten fan.
- Replace cover plate (8) on radiator cladding.

TENSING THE V-BELT

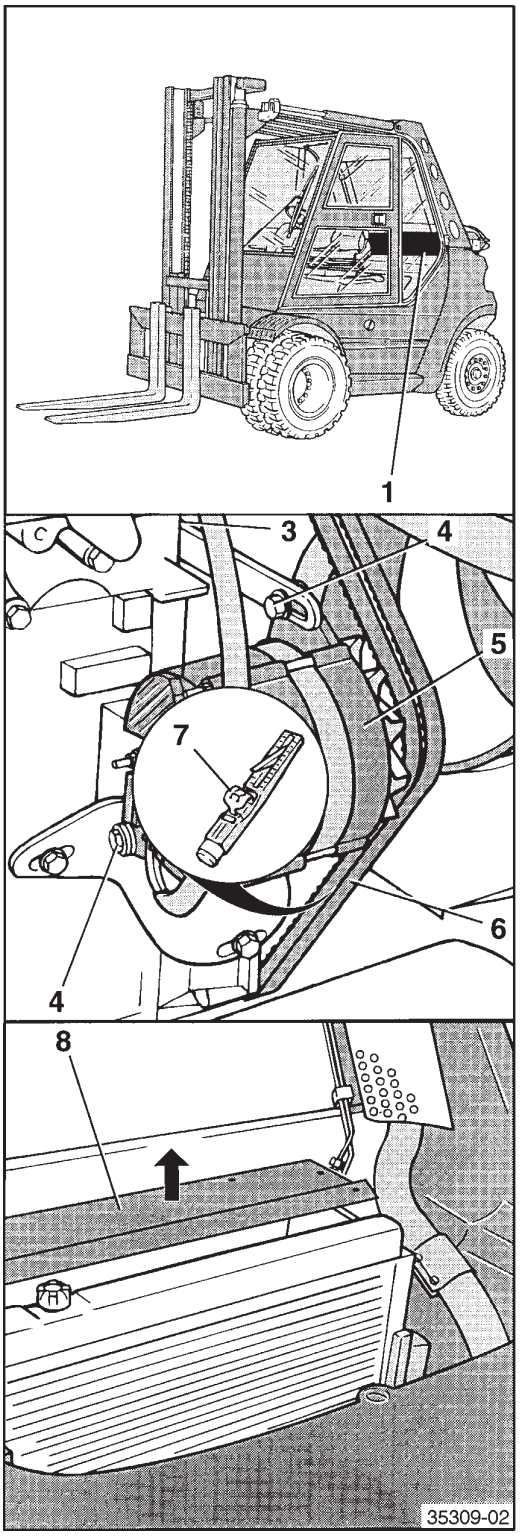
- Turn alternator (5) until the correct V-belt tension is obtained.
- Re-tighten fastening screw (4) and hexagon nut (3).
- Check V-belt tension, adjust tension if necessary.

Test with meter:
Place meter (7) on V-belt (6) and take measurement.
Measurement 355 N

Test by pressing with thumb:

- Check V-belt by pressing with thumb.
- It must be possible to press the V-belt in about 10 mm between the V-belt pulleys.
- Increase the tension if it is insufficient.

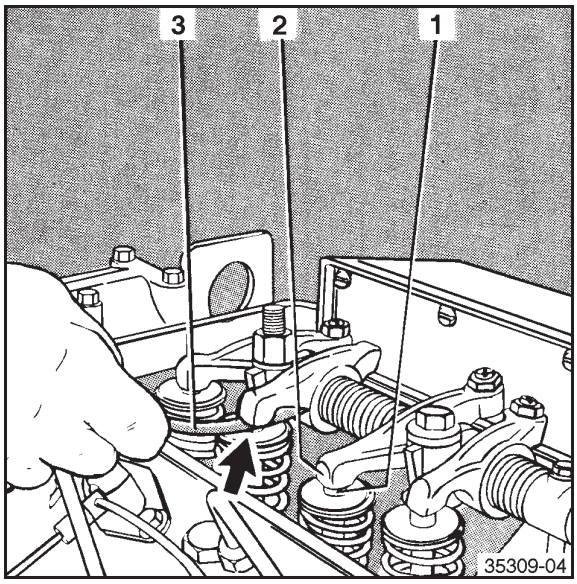
NOTE: Adjust tension of new V-belts after about 15 - 20 minutes time in operation.



4.9.1.4 CHECKING AND SETTING VALVE CLEARANCE

The valve clearance is to be checked and adjusted only with the engine cold.

- Remove valve cover.



- Turn the engine with screwdriver through opening in the middle housing on toothed flywheel ring until the valves on the 6th cylinder overlap.
  In this position, check the valve clearance of the first cylinder and adjust if necessary.

- Turn the flywheel further until the valves of the 2nd cylinder overlap.
  Check the valves on the 5th cylinder and adjust if necessary.

- Turn the flywheel further until the valves of the 4th cylinder overlap.
  Check the valves on the 3rd cylinder and adjust if necessary.

- Turn the flywheel further until the valves of the 1st cylinder overlap.
  Check the valves on the 6th cylinder and adjust if necessary.

- Turn the flywheel further until the valves of the 5th cylinder overlap.
  Check the valves on the 2nd cylinder and adjust if necessary.

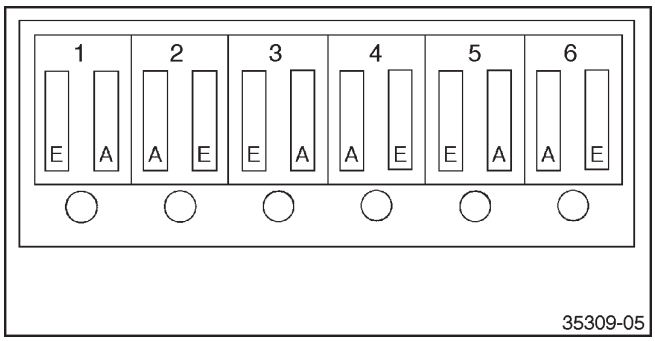
- Turn the flywheel further until the valves of the 3rd cylinder overlap.
  Check the valves on the 4th cylinder and adjust if necessary.

- Check the valve clearance between valve (1) and valve lifter (2) with a feeler gauge (3).

  Target value, cold valve clearance:

Inlet valve	0.20 mm
Outlet valve	0.45 mm

The position of the inlet and outlet valves are shown in the diagram.

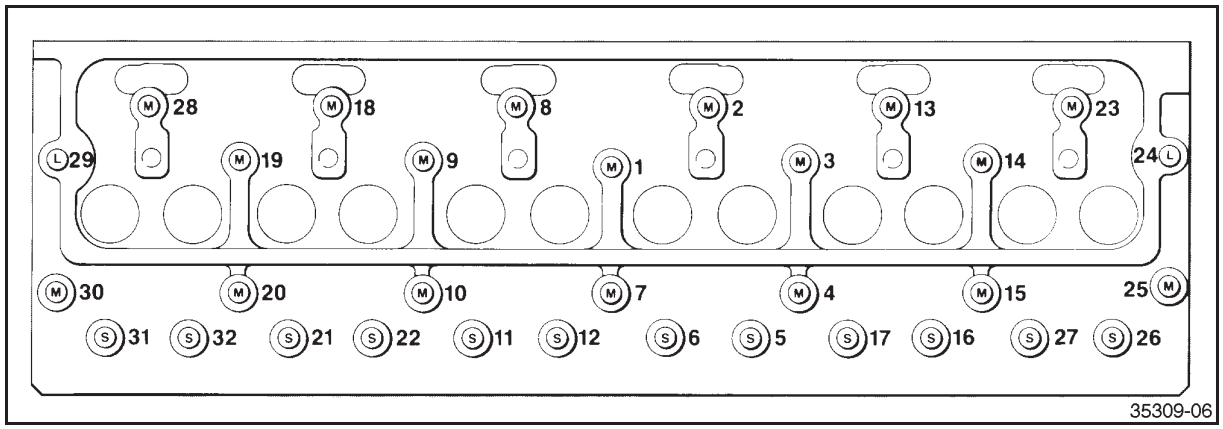


E = inlet valve
A = outlet valve

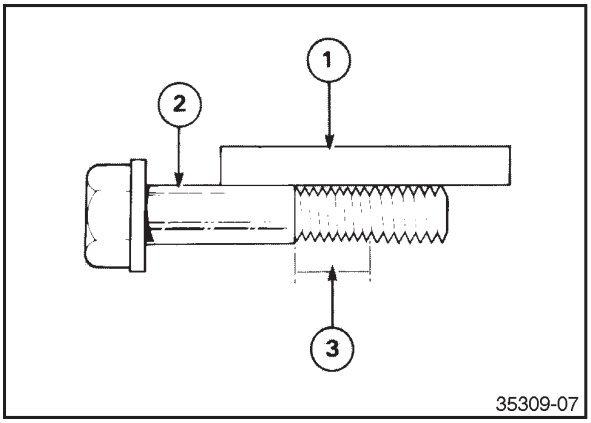
NOTE: The 1st cylinder is on the water pump side.

4.9.1.5 REMOVING AND INSTALLING THE CYLINDER HEAD

REMOVING THE CYLINDER HEAD



- Loosen cylinder head screws uniformly and gradually in an alternating spiral sequence, as shown in the diagram.
- Check cylinder head screws, with a ruler (1), for deformation of the screw shaft (2).
- Check the screw for a visible reduction of thread size close to the screw shaft (3).
- If the check on the cylinder head screws gives cause to reject them, deformed or stretched screws are to be replaced.

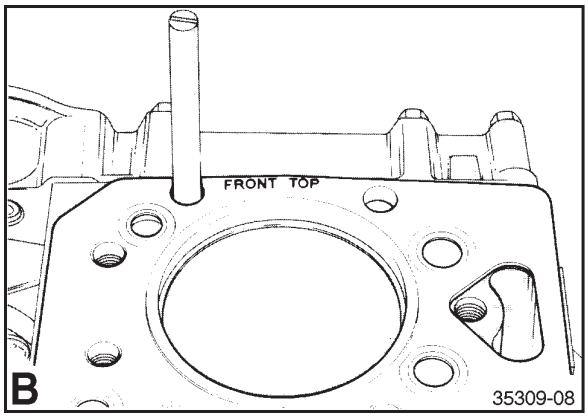


INSTALLING THE CYLINDER HEADS

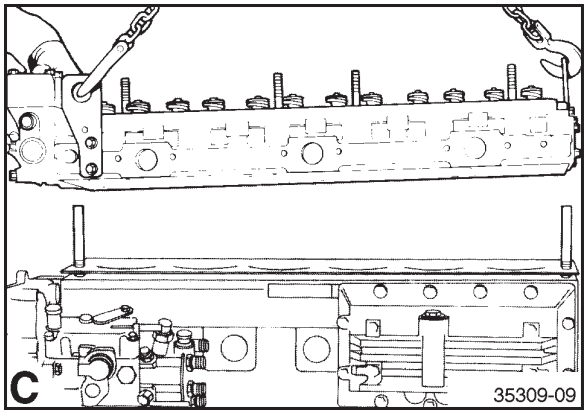
- Clean the sealing face of the cylinder head and engine block. No residue of sealant must remain on the sealing faces.
- Check cylinder head for distortion.
  WARNING The sealing face of the cylinder head must be overhauled in the following cases:
  Deformation and distortion of the cylinder head by more than 0.05 mm.
  Deep scratches.

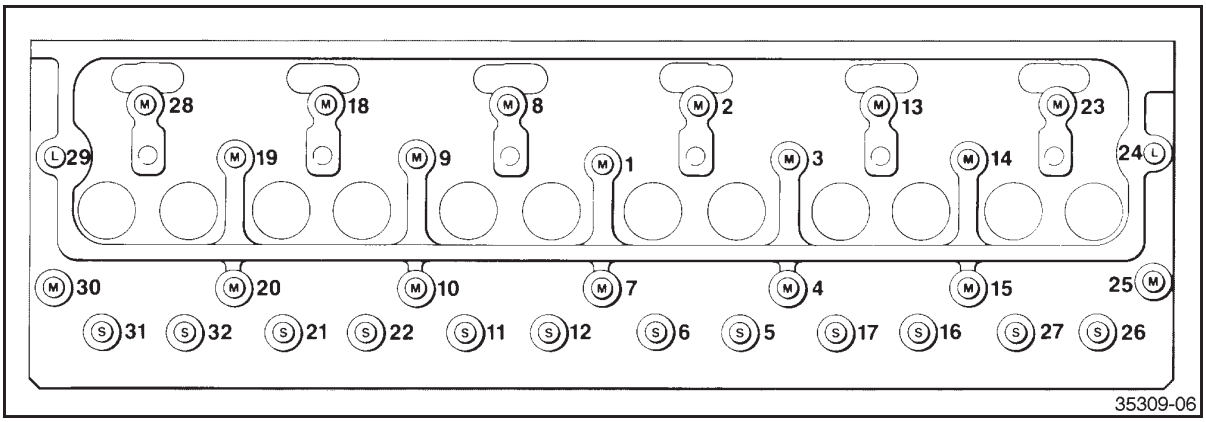
- Insert new cylinder head seal without additional sealant (B).

NOTICE: Before installation of the cylinder head, clean the thread holes in the engine block.



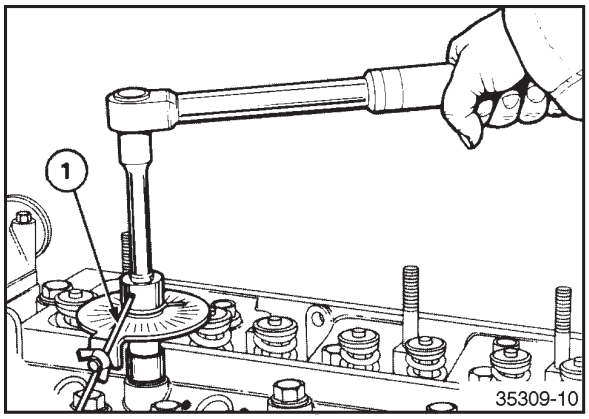
- In order to keep the cylinder head seal in the correct position for assembly of the cylinder head, screw two 1/2 UNF stud bolts into the motor block (C).





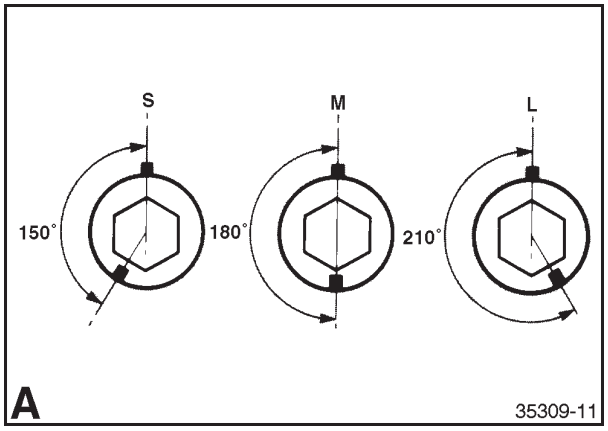
- Lightly oil the cylinder head screw thread and tighten to 110 Nm in accordance with diagram.
- Tighten cylinder head screws in the order shown in the diagram taking account of the length:
  Tighten short screws (S) another 150°.
  Tighten medium-length screws (M) another 180 °.
  Tighten long screws (L) another 210 °.

- If there is no torque measuring tool (1) available, mark the position of each individual screw on the cylinder head in relation to a corner point (A).



- Mark the correct angle (in a clockwise direction) on the top of each screw in accordance with length (S, M or L).
- Tighten the screws in the correct order until they are adjusted in accordance with the marks made on the cylinder head.

WARNING It is not necessary to tighten the cylinder head screws when the motor is warm or after 50 hours of operation.



4.9.2 ELECTRICAL SYSTEM

4.9.2.1 ELECTRONIC IGNITION SYSTEM

4.9.2.1.1 ELECTRONIC IGNITION SYSTEM UP TO 12/2004

The motor is equipped with a Bosch contactless transistor-coil ignition (TSZ [German abbreviation]) .

Control of the spark ignition without mechanical contact provides the following advantages:

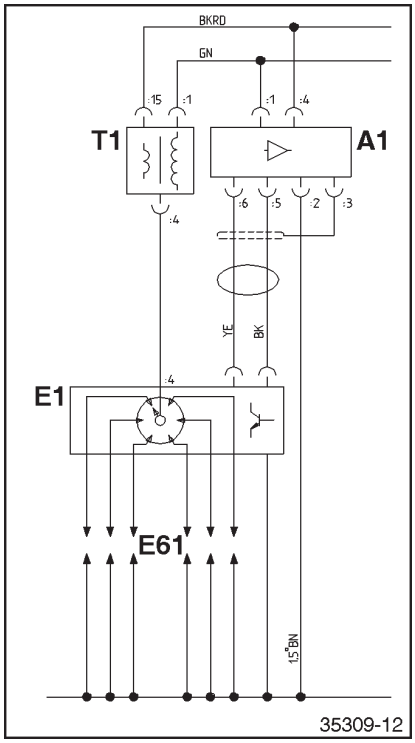
- Ignition electronics and ignition generator work with no wear and consequently need no maintenance whatsoever.

- The ignition timing can be exactly controlled for all operating conditions of the engine and remains almost constant throughout the entire service life of the ignition distributor.

- Great ignition reliability at high speed, and optimum power consumption at low speeds as a result of control of the dwell angle and the absence of contact bounce.

The principal characteristic of this ignition system is the ignition pulse generator, which replaces the cam-controlled contact breaker. The ignition pulse generator has the job of generating control pulses without mechanical assistance, i.e. “contactless”. The control pulses are supplied to the electronic switchgear. The pulses are produced by the induction-type pulse generator in the ignition distributor.

FUNCTIONAL DIAGRAM

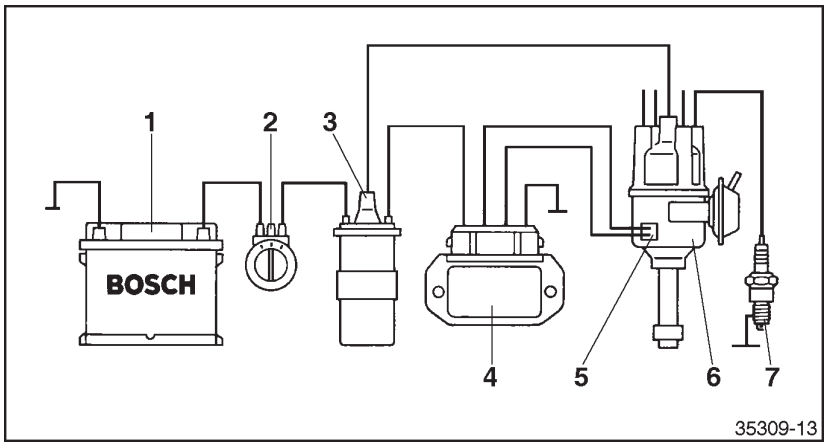


Terminal “15” of the ignition lock

A1 = Switchgear
E1 = Ignition distributor with induction-type pulse generator
E61 = Spark plugs
T1 = Ignition coil

COMPONENTS OF A TRANSISTOR IGNITION SYSTEM

1 Battery
2 Ignition starting switch
3 Ignition coil
4 Switchgear
5 Transmitter
6 Ignition distributor
7 Spark plug(s)



FUNCTIONING OF THE IGNITION SYSTEM

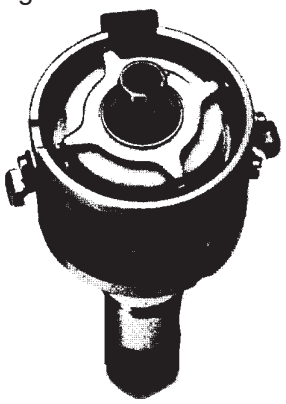
The ignition system consists of the following components:
Battery (1) as the energy source. The primary current flows from the battery through the ignition starting switch (2) (when switched on) and the primary winding of the ignition coil (3) back through the switchgear (4). The activation of the interruption of the primary current by the switchgear is controlled by an induction pulse generator (5) in the ignition distributor (6).

At the moment when the primary current is interrupted, a high voltage is induced in the secondary winding of the ignition coil, which is distributed by the ignition distributor to the appropriate spark plug (7).

INDUCTIVE ACTIVATION OF THE IGNITION

Permanent magnet (1) and induction winding (2) form the stator. The rotor, which rotates against the stator, is positioned on the timer core (4) located on the ignition distributor shaft. The core and rotor are made of soft magnetic steel and have pointed extensions (stator arms and rotor arms). As the rotor turns, the air gap (3) between stator arms and rotor arms periodically changes. As this happens the magnetic power flux changes. This change of flux finally induces an a.c. voltage in the induction winding.

Ignition distributor with induction-type pulse generator

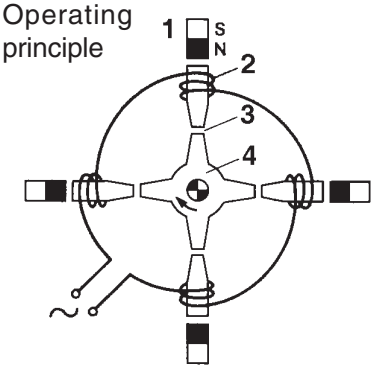


GENERATION OF THE TRANSMITTER VOLTAGE

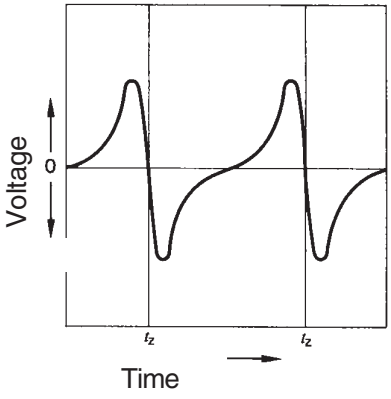
The approach of the stator arm and the rotor arm increases the magnetic flux. This change in flux induces a voltage in the induction winding; this voltage rises to a peak value which is reached just before the arms come opposite each other. As the timer core continues to turn, the arms move apart and the transmitter voltage changes direction. The pulse transmitter has generating properties, and it generates an a.c. voltage for the contactless ignition control. The a.c. voltage frequency corresponds to the spark frequency.

1 Permanent magnet
2 Induction winding with core
3 variable air gap
4 Timer core

Operating principle



Induction voltage progression



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FUNCTIONING OF THE TRANSISTOR COIL IGNITION (TSZ)

The a.c. control voltage delivered by the induction generator is converted into rectangular pulses in the switchgear. These pulses control the switching on and off of the primary coil current and thus the induction of the high voltage in the secondary winding of the ignition coil.

NOTES: At this point we would point out that the switchgears of the TSZ are only safe in certain circumstances from polarity reversal from switching. For instance, an incorrect connection of the battery to the [truck's] power supply system must be detected and corrected within a few seconds, otherwise there is a danger that the electronics will be damaged.

The plug-in connections on the switchgear and on the ignition distributor are made in such a way that they can only be fitted with the correct polarity (moulded plugs). Therefore no polarity reversal is to be feared because of these components.

As a rule, electronic ignition systems have higher ignition power than traditional ignition systems. Electronic ignition systems work in a power range that is potentially lethal if bare terminals and voltage-carrying parts are touched. This applies both to the low voltage parts (primary current circuit) and the high voltage parts (ignition circuit) of such equipment.

When working on the ignition system, the ignition must always be switched off or the power source to be disconnected. Such operations include:

- Changing of parts such as spark plugs, ignition coils or transformers, distributors, cables, etc.

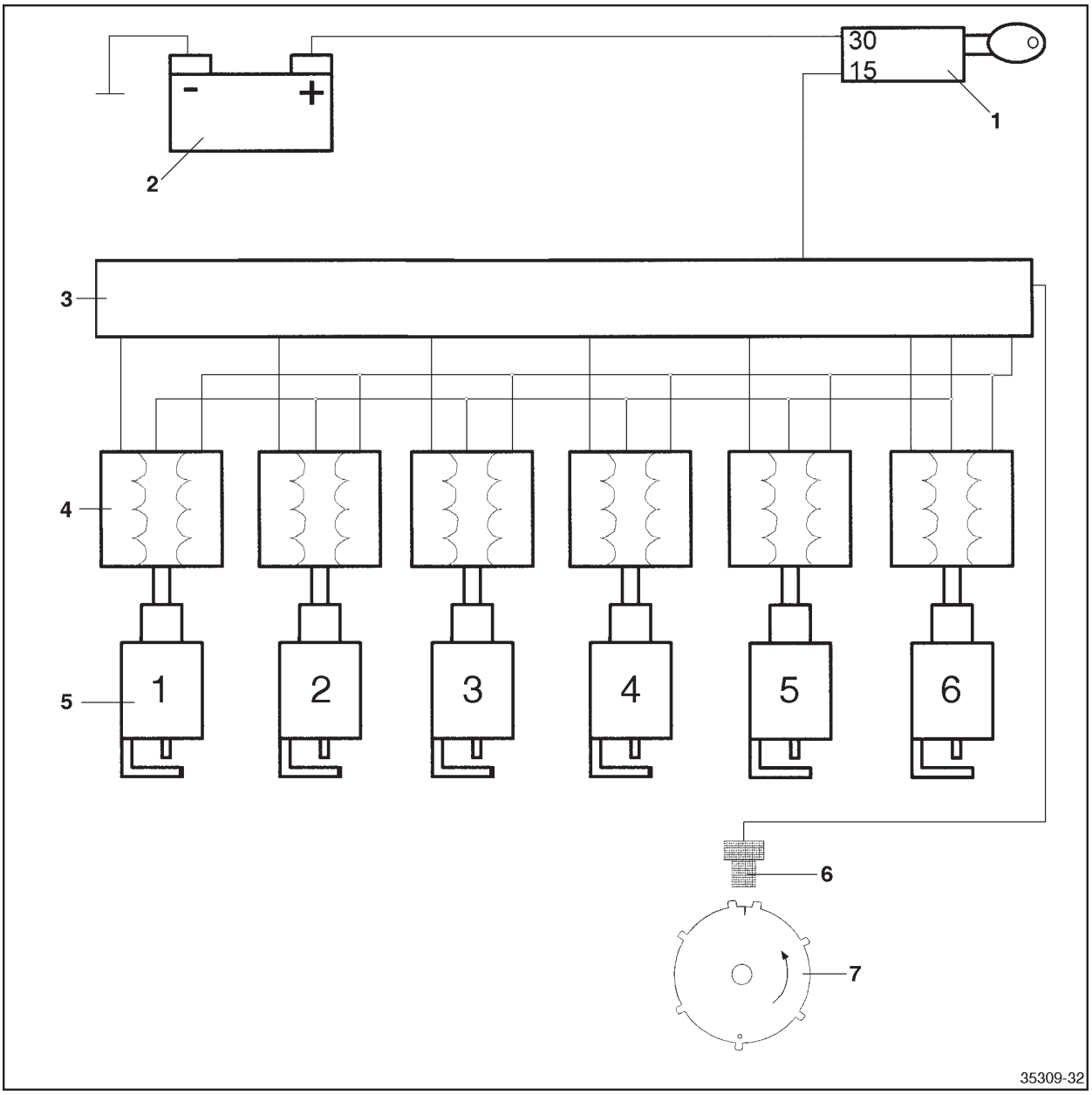
- Connecting of engine test devices such as timing lights, dwell-tachometers, ignition oscilloscopes, etc.

If it is necessary to switch on the ignition in order to work on the ignition system or the engine, dangerous voltages occur in the whole ignition system both in its components and in the wiring harness, as well as in the diagnostic connector, the tachometer connection, the plug connections and the test equipment.

So: TAKE CARE WHEN WORKING ON ELECTRONIC IGNITION SYSTEMS!!!

4.9.2.1.2 ELECTRONIC IGNITION SYSTEM FROM 01/2005

FUNCTIONAL DIAGRAM



1 Ignition switch
2 Battery
3 Ignition electronic unit
4 Ignition coil
5 Spark plugs
6 Pickup
7 Toothed disc

DESCRIPTION

The engine is equipped with an integrated electronic ignition system without contact breaker points.

Due to its design, the ignition system is reliable, non-adjustable and has the following advantages:

- No centrifugal advance.
- Permanent stability of the ignition timing curve.
- High secondary voltage.
- No wear of the controller due to a magnetic pickup without mechanical contact.
- Ignition and ignition advance are controlled by an electronic controller which is programmed accordingly.

METHOD OF OPERATION

A fully electronic ignition, as in this case, is a static installation, which provides the ignition spark for the operation of the engine at the correct time.

The electronic ignition system employed, uses a toothed disc to generate pulses. The system uses individual ignition coils mounted on each spark plug.

The ignition pulses are conducted to the ignition coils in the firing order and from there to the respective spark plugs.

The main feature of this ignition system is the electronic controller, which receives all pulses and signals and, after processing them, performs or initiates the following functions.

The control of the primary circuit of the ignition coils is by means of the ignition electronics. A regulation of the ignition timing, depending on the engine speed (information of the generator) is possible.
A spark is generated with a constant energy independent of the battery voltage and the speed of the engine.
The sparks reach the spark plug directly without a high tension ignition cable.

DESIGN CHARACTERISTICS OF THE TEETH

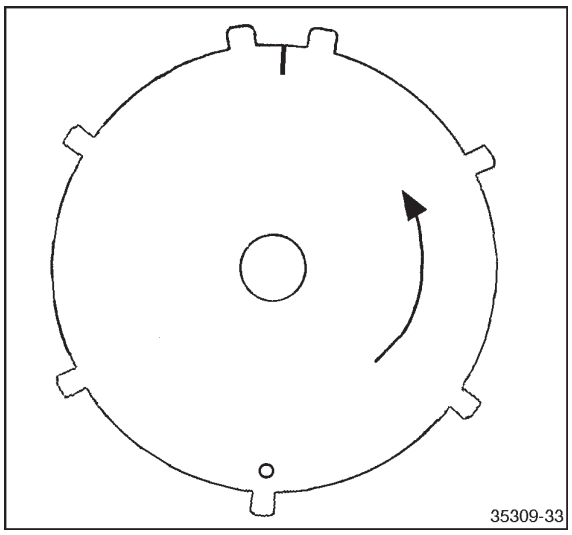
All electronic ignition systems require a pickup for sensing the engine speed for the control of the primary circuit and the ignition timing, in order to continually adjust the ignition timing to the operating state of the engine.

With the electronic ignition system, the ignition is controlled by means of teeth on a toothed disc, which is driven by the engine timing gear.

TRANSMISSION OF THE PULSES

The purpose of the advance angle sensor (generator) is to generate a pulse whenever it passes a tooth.

The electronic controller receives a unique pulse whenever a specially formed tooth passes the generator. This allows the top dead centre point (TDC) to be determined accurately.



ADVANCE ANGLE SENSOR

This sensor is a magnetic pickup mounted adjacent to the teeth of the toothed disc. This magnetic pickup consists of a permanent magnet with an inductive coil in which a voltage is induced when it passes the teeth.

These voltages are transmitted to the electronic controller as information on engine speed and position of the crankshaft.

NOTE: The position of the generator in relation to the toothed disc can not be changed.

IGNITION COIL

The ignition coil is largely identical with coils of conventional ignition systems in construction and in operation.

A single coil, which is plugged on the plug without a high tension lead and screwed to an angle bracket, is used for each spark plug.

ELECTRONIC CONTROLLER

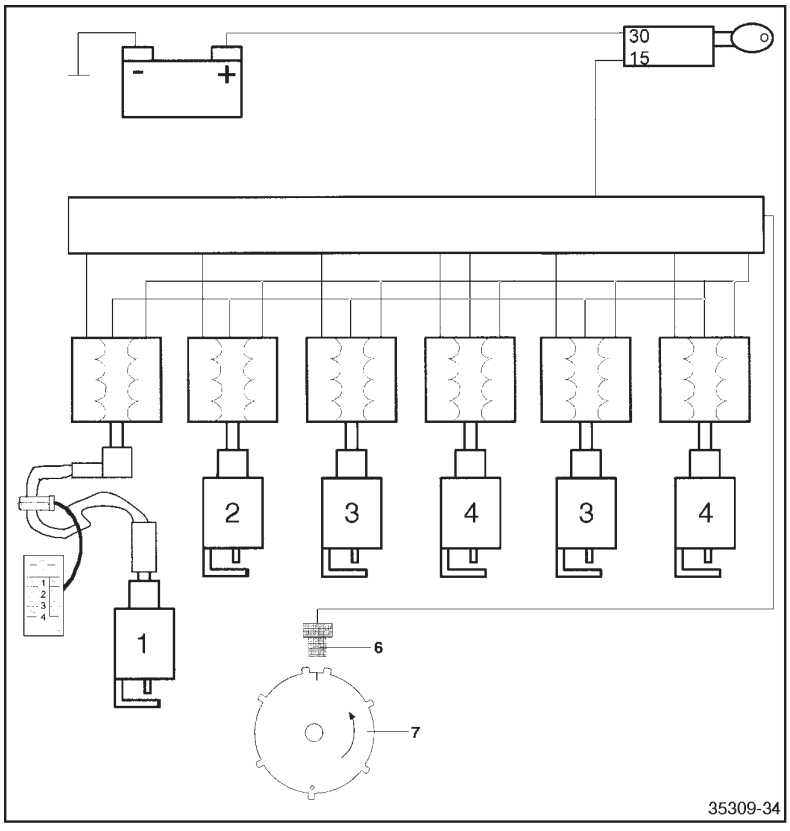
The electronic controller is comparable to a computer. The pulses coming from the generator allow the electronic controller to determine the speed of the engine exactly. The controller compares the current speed with the firing point programmed into the ignition characteristic map and triggers the ignition spark via the appropriate ignition coil with high precision.

CHECKING THE IGNITION TIMING

A timing light is required for measuring the ignition point. It must be connected between the ignition coil and spark plug of the number 1 cylinder. For the check, the ignition coil must be unscrewed from the bracket of the number 1 plug. The removed coil is then connected, using a spare ignition cable to the spark plug, the timing light can then be attached to this cable.
NOTE: A conventional spark plug HT lead is required for this test.

The firing point is 8° ± 2° BTDC at an idle speed of 750 $^{+\ 50}$ rpm.

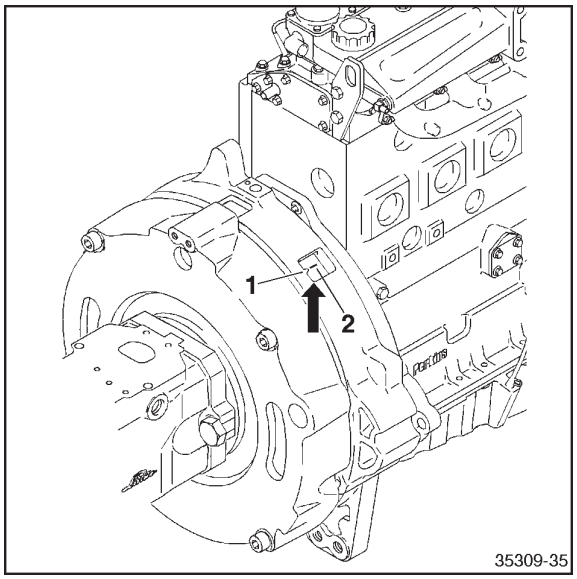
CONNECTING DIAGRAM FOR SPARK PLUG CABLES



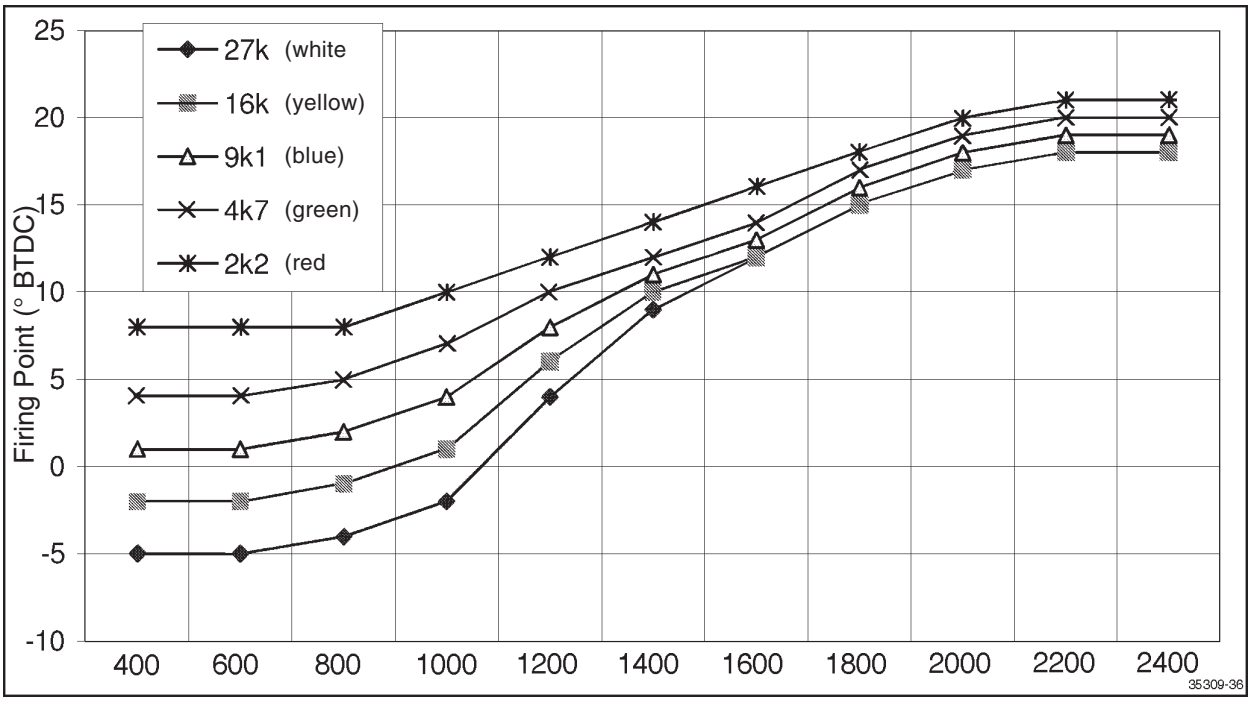
MARKING THE FIRING POINT

The firing point is fixed by the ignition electronics and can only be adjusted in the direction of "retarded" with appropriate resistors (see circuit diagram).

1 Firing point mark on housing
2 Firing point mark on flywheel

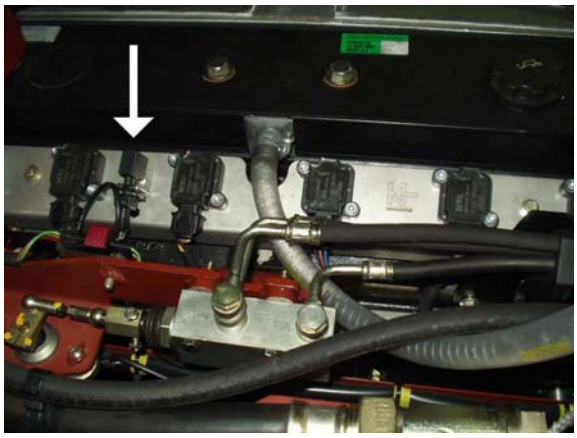


FIRING POINT CHARACTERISTIC CURVE FOR 1006-EGSI



Eng. speed (rpm)	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
27k (white)	-5	-5	-4	-2	4	9	12	15	17	18	18
16k (yellow)	-2	-2	-1	1	6	10	12	15	17	18	18
9k1 (blue)	1	1	2	4	8	11	13	16	18	19	19
4k7 (green)	4	4	5	7	10	12	14	17	19	20	20

The firing point caracteristic curve is controlled by a resistor. The picture besides shows the position of the resistor in the truck.

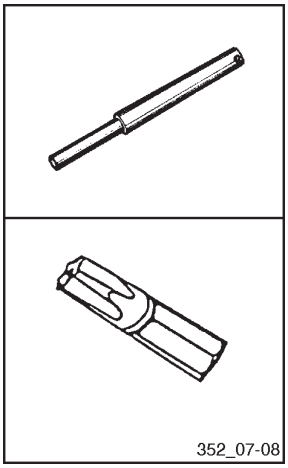


4.9.2.1.2.1 MECHANICAL IGNITION TIMING

SPECIAL TOOLS REQUIRED

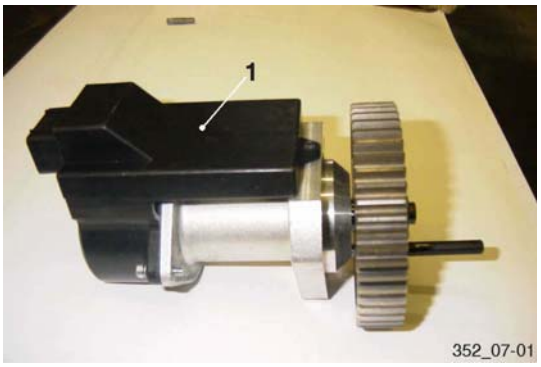
Timing pin for ignition system
Part no. 000 008 61 00

Torx driver for ignition system
ET-Nr. 276 10 122



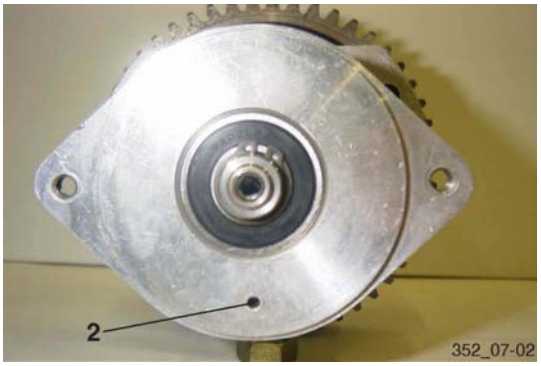
CHECKING THE MECHANICAL IGNITION TIMING ARRANGEMENT IN SITU

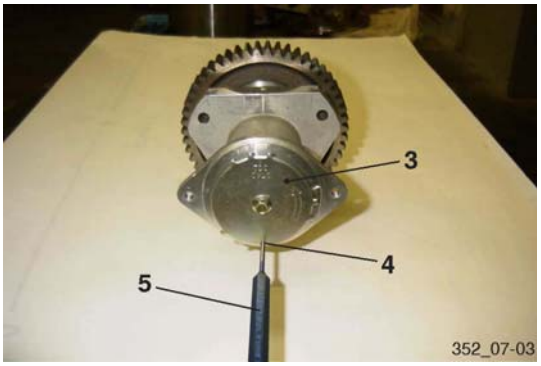
- Set cylinder 1 of the internal-combustion engine at top dead centre on the compression stroke.
- Pull off the connector of the ignition control unit (1).
- Unscrew and remove the ignition control unit (1).



- Push the timing pin Ø 3 mm (5) through the hole (4) in the toothed disc (3) into the hole in the housing (2).

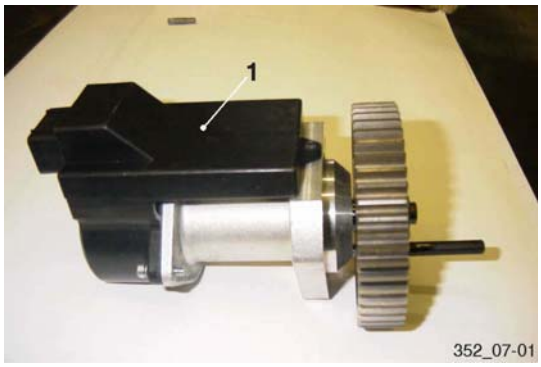
NOTE: The mechanical adjustment is correct, if both holes align when the engine is set at TDC.



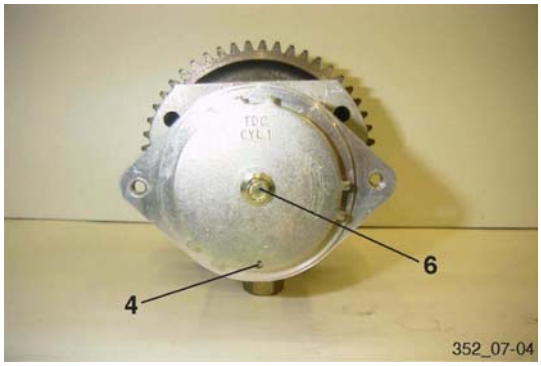


ADJUSTING THE TOOTHED DISC IN SITU

- Set cylinder 1 of the internal combustion engine at top dead centre on the compression stroke.
- Pull off the connector of the ignition control unit (1).
- Unscrew and remove the ignition control unit (1).

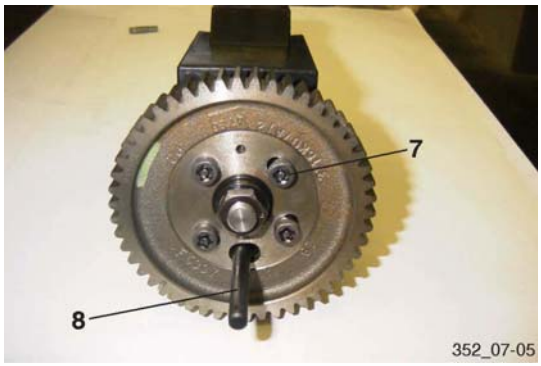


- Loosen the screw (6).
- Rotate the toothed disc (2) until the hole in the toothed disc (4) aligns with the hole in the housing (2).
- Insert the 3mmtiming pin (5) .
- Tighten the screw (9 Nm).



REMOVING THE IGNITION CONTROL UNIT

- Disconnect the battery.
- Set cylinder 1 of the internal combustion engine at top dead centre on the compression stroke.
- Remove the cover on the timing case.
- Push timing pin (8) through the gear wheel and the recess in the hub into the hole in the housing.
- Remove the four screws (7) with the help of the special tool (10).
- Unscrew the three M8 nuts on the flange of the ignition timing unit (1) and remove ignition control unit.



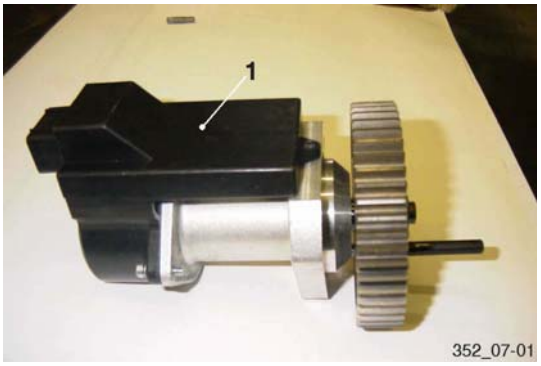
CAUTION: Insert a lint-free cloth between the face end of the injection pump gear wheel and the timing case to ensure that the screws fastening the gear wheel to the pump hub will not drop into the timing case. If this happens, you will need to dismantle the entire timing case.

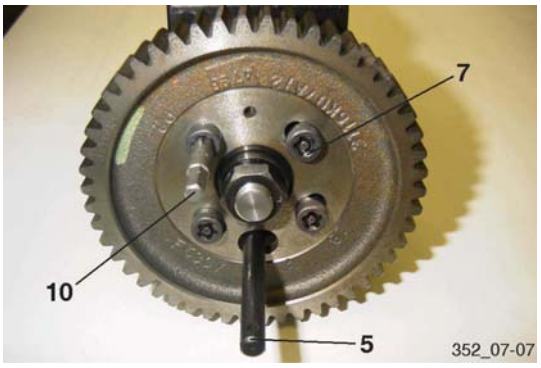
INSTALLING THE IGNITION CONTROL UNIT

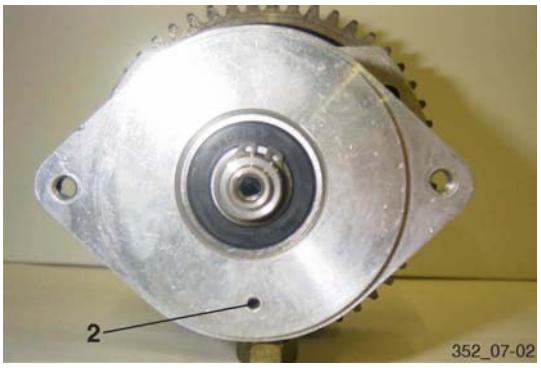
NOTE: Prior to installing the ignition control unit, set cylinder 1 of the internal combustion engine at top dead centre on the compression stroke.

- Push timing pin (9) through the recess in the hub into the hole in the housing.
- Check by inserting the 3mm timing pin (5) through the toothed disc into the housing.
- Check the O-ring on the flange and replace, if necessary.

- Place the ignition control unit (1) in the mounting position. Be sure to push the pin through the slot in the gear wheel.
- Fasten the flange by means of the M8 nuts and tighten the nuts to 22 Nm.
- Push the gear wheel against the hub and fasten the gear wheel with the help of the special screws (7). Tighten the screws to 28 Nm.
- Withdraw the timing pin.
- Mount the timing case cover.
- Install the connector of the ignition control unit.







4.9.2.2 ELECTRONIC ENGINE-SPEED CONTROL

FUNCTION OF THE CONTROL SYSTEM

With gas-propellant trucks, the engine speed is kept constant, up to the performance limits of the engine, with the electronic control system, in spite of varying loads caused by the drive and lift hydraulics. Thus the engine power corresponds to the appropriate r.p.m., according to the pedal setting (transmission).

ADVANTAGES OF THE CONTROL SYSTEM

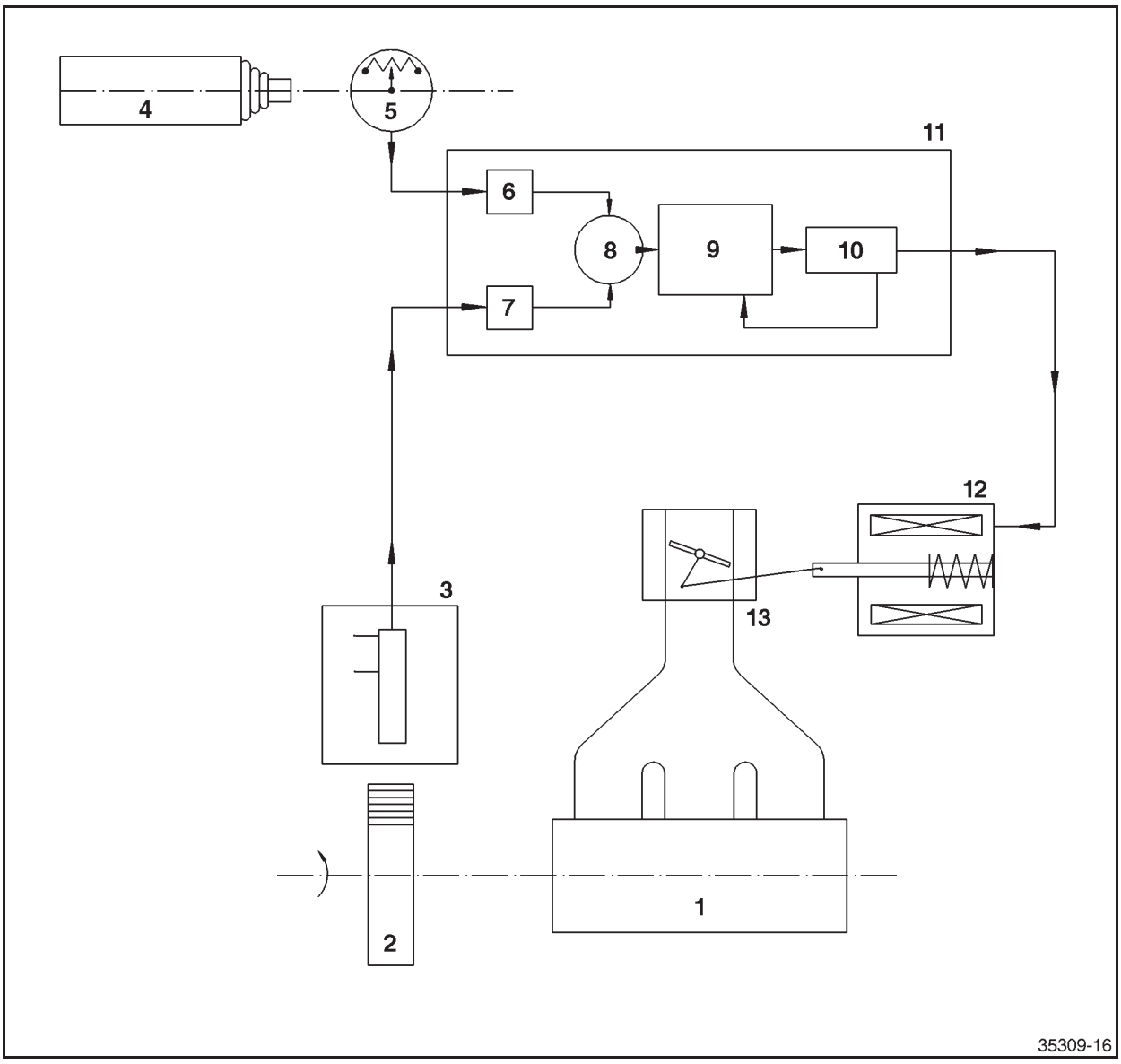
The control system has an electronic regulator with proportional, integral and differential operation. The following advantages follow from these properties in comparison with proportional regulators [alone]:

- No pressure on the drive motor;
  i.e. maximum idling speed = rated speed;
  resulting in a reduction of noise and gas consumption.

- Regulation of idling speed;
  i.e. no need for idling-speed limiting screw, resulting in very minor engine speed changes with variations in engine temperature.

- No engine speed adjustment required,
  so that the r.p.m.speed regulator can be replaced without adjustment.

BLOCK DIAGRAM OF THE ENGINE SPEED REGULATOR



1 Perkins gas engine
2 Flywheel with starter ring gear
3 Speed indicator
4 Speed setting cylinder (hydraulically controlled)
5 Nominal value transmitter (rotary potentiometer)
6 Nominal value signal processing
7 Actual value signal processing
8 Nominal value / actual value comparison
9 PID regulator
10 Output stage
11 Engine speed regulator
12 Modulator (proportional magnet)
13 Propellant gas mixer with throttle valve

NOMINAL VALUE TRANSMITTER

The nominal value transmitter (5) is adjusted, via a hydraulic modulator (4), in accordance with the pedal position and the actuation of the operating hydraulics. This adjustment changes the nominal value transmitter (5) into a proportional electrical signal.
A conductive plastic potentiometer is built into the nominal value transmitter (5) with an electrically active adjustment range of 44 °. The potentiometer is splash-proof and designed for the environmental requirements for vehicles in terms of temperature, vibration acceleration and corrosion protection.
The input value delivered from the nominal value transmitter (5) is adapted to the nominal value processing (6).

ACTUAL VALUE TRANSMITTER

The actual value transmitter (3) detects the engine speed inductively via the starter ring gear. This induces an a.c. voltage in it, with a frequency proportional to the speed. The speed sensor is a proven component in vehicle technology.
In the speed signal processing, the a.c. voltage delivered from the actual value transmitter (3) is changed into a d.c. voltage proportional to the speed.

TARGET VALUE / ACTUAL VALUE COMPARISON

At the nominal value / actual value comparison point (8), the nominal value received from the pedal position is compared with the engine speed measured by the actual value transmitter (3). In accordance with the regulating difference, the speed regulator (11) changes the setting of the throttle valve, via the modulator (12). Thus the nominal value (speed) set is kept constant, irrespective of the engine load. In addition, the two stop positions of the throttle valve are indicated via the magnet current capture of the PID regulator (9).

PID REGULATOR

The nominal value and actual value are compared and the difference is transmitted to the PID regulator (9). The PID regulator (9) has a proportional, differential and integral element.

OUTPUT STAGE

The output stage (10) amplifies the output signal of the PID regulator (9) so that the operating magnet (12) can be activated. A pulse-pause-controlled, clocked output stage is operated in this way.
The current of the operating magnet (12) is detected on a measuring resistor in the control system and is recoupled to the output stage (10). In this way, the stability of the regulating circuit is improved.
For detection of the throttle valve stop positions (fully open or fully shut), the current flowing via the operating magnet is measured. When the power and thereby also the direction of the magnet axis change in proportion to the current, the PID regulator (9) recognises the position of the throttle valve and its end positions from the current.

MODULATOR

The modulator (12) is a proportional magnet with a built-in return spring. By raising the magnet current, the throttle valve is opened and the return spring is tensed, by means of a rod assembly. In the event of a power failure or a break in the cables, the throttle valve is shut by the return force of the spring.

4.9.2.3 ELECTRICAL SYSTEM CIRCUIT DIAGRAM

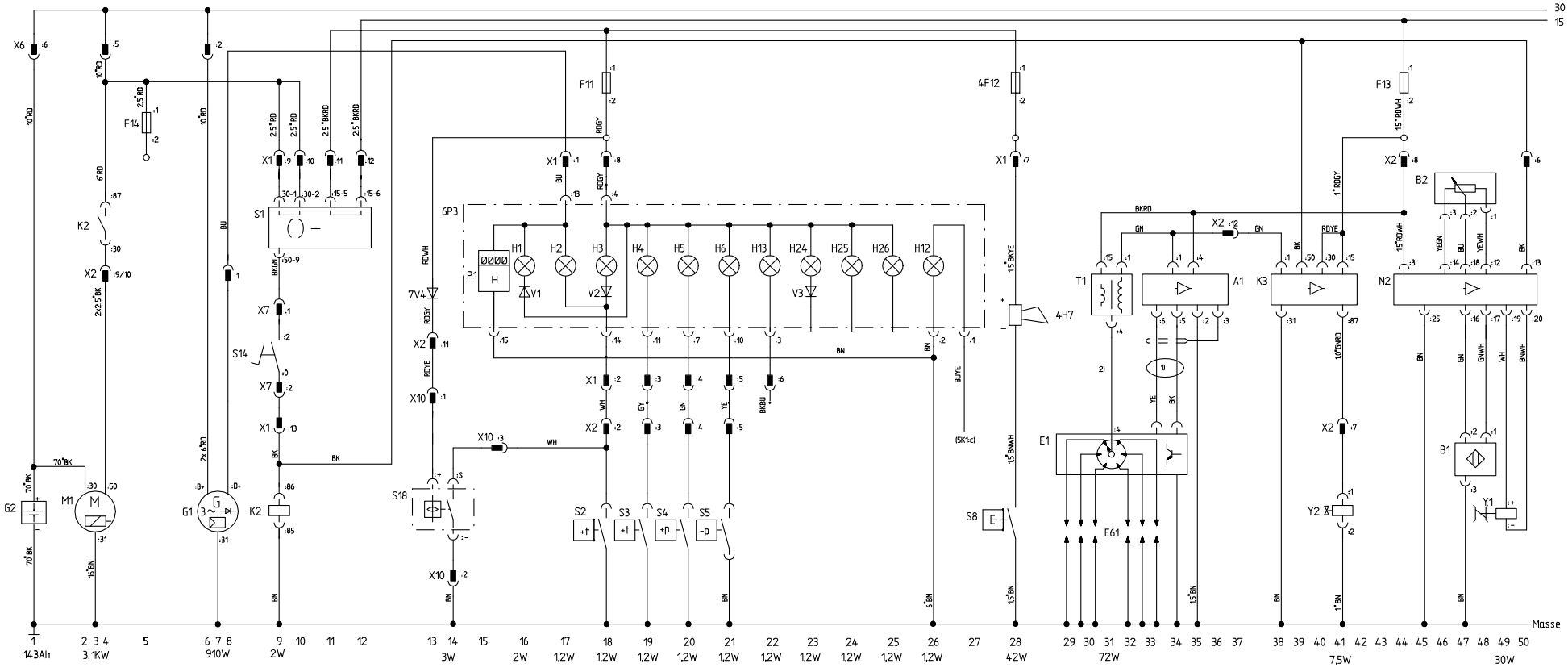
4.9.2.3.1 ELECTRICAL SYSTEM CIRCUIT DIAGRAM UP TO 12/2004

A1	Ignition control device	33-35
B1	Actual speed transmitter	47,48
B2	Set speed transmitter	46-48
E1	Ignition distributor	29-34
E61	Spark plugs	29-33
F11	5A display device fuse	18
F13	5A speed regulator fuse	44
F14	15 A free 30 potential fuse	5
4F12	5A audible warning device fuse	28
G1	Alternator with regulator	7
G2	Battery	1
H1	Charge indicator	16
H2-3	Engine temperature indicator	17,18
H4	Hydraulic fluid temperature indicator	19
H5	Oil pressure indicator	20
H6	Suction filter vacuum indicator	21
H12	Turn signal indicator	26
H13	Fuel remaining indicator	22
4H7	Horn	28
K2	Relay for starter motor	3,9
K3	Propellant gas control relay	38-41
N2	Engine speed regulator	44-50
M1	Starter motor	3
P1	Operating hours counter	15
6P3	Indicator equipment	15-27
S1	Ignition starter switch	9- 2
S2	Engine temperature switch	18
S3	Oil temperature switch	19
S4	Oil pressure switch	20
S5	Suction filter vacuum switch	21
S8	Horn button	28
S14	Brake pedal switch	9
S18	Cooling water level sensor	13,14
T1	Ignition coil	30-32
V1-3	Decoupling diodes	16,18, 23
7V4	Decoupling diode	13
X1	15-pin plug	9-28
X2	12-pin plug	3-21, 36 -50
X6	6-pin plug	1,3,7
X7	2-pin plug	9
X10	3-pin plug	13-15
Y1	Speed operating magnet	49
Y2	Propellant gas shutoff valve	41

CABLE COLOURS

BK	black
BN	brown
BU	blue
GN	green
GY	grey
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

CIRCUIT DIAGRAM H 50/60/70/80 T, TYPE 353, UP TO 12/2004



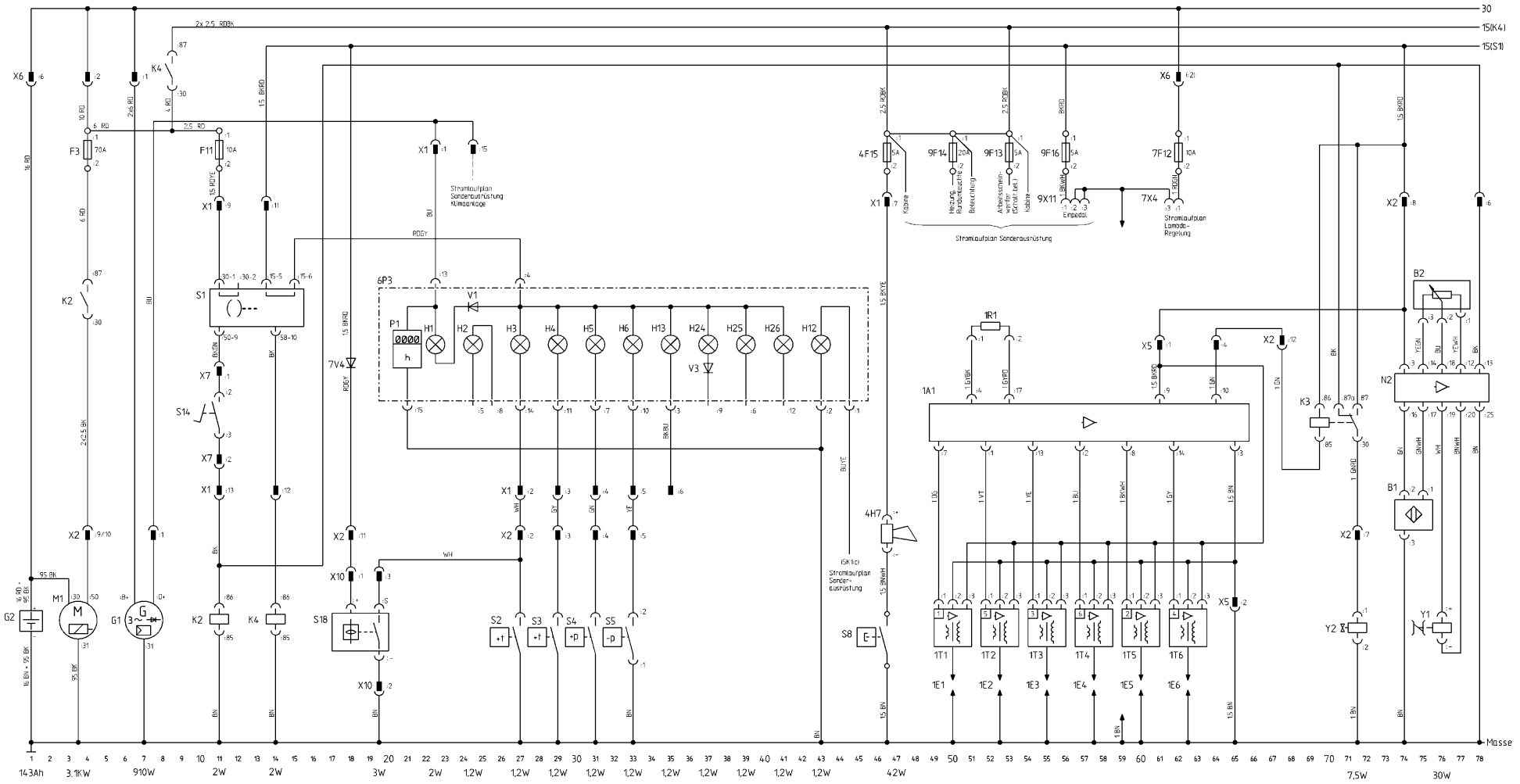
4.9.2.3.2 ELECTRICAL SYSTEM CIRCUIT DIAGRAM FROM 01/2005

A1	Ignition control device	49-66
B1	Actual speed transmitter	74-75
B2	Set speed transmitter	75-77
1E1	Spark plug cylinder 1	50
1E2	Spark plug cylinder 2	52
1E3	Spark plug cylinder 3	55
1E4	Spark plug cylinder 4	57
1E5	Spark plug cylinder 5	60
1E6	Spark plug cylinder 6	62
F3	Fuse MTA	4
F11	Fuse (terminal 30, S1)	11
4F15	Audible warning device fuse	47
7F12	Fuse lambda control	62
9F13	Fuse for switch lamps, working lights	53
9F14	Fuse heating system	49
9F16	Fuse single pedal version	56
G1	Alternator with regulator	6-8
G2	Battery	1
H1	Charge indicator	22
H2	Controller fault warning lamp	24
H3	Engine temperature indicator	27
H4	Hydraulic fluid temperature indicator	29
H5	Oil pressure indicator	31
H6	Suction filter vacuum indicator	33
H12	Turn signal indicator	43
H13	Fuel remaining indicator	35
H24	Fan	37
H25	Preheating	39
H26	Particles filter - warning	41
4H7	Horn	47
K2	Relay for starter motor	4,11
K3	Propellant gas shutoff relay	69-72
K4	Auxiliary relay, terminal 15	9,17
N2	Engine speed regulator	74-78
M1	Starter motor	3-4
P1	Operating hours counter	21
6P3	Indicator equipment	20-46
1R1	Resistor	51-53
S1	Ignition starter switch	11-15
S2	Engine temperature switch	27
S3	Oil temperature switch	29
S4	Oil pressure switch	31
S5	Suction filter vacuum switch	33
S8	Horn button	47
S14	Brake pedal switch	11
S18	Cooling water level sensor	17-20
1T1	Ignition coil cylinder 1	49-51
1T2	Ignition coil cylinder 2	52-53
1T3	Ignition coil cylinder 3	54-56
1T4	Ignition coil cylinder 4	57-58
1T5	Ignition coil cylinder 5	59-61
1T6	Ignition coil cylinder 6	62-63
V1/3	Decoupling diodes	24,37
7V4	Decoupling diode	18
X1	15-pin plug	11-35,47
X2	12-pin plug	4-78
X5	4-pin plug	61-65
X6	6-pin plug	1-7,62
X7	2-pin plug	11
X10	3-pin plug	18,19
7X4	3-pin plug	61-62
9X11	3-pin plug	56-58
Y1	Speed operating magnet	49
Y2	Propellant gas shutoff valve	41

CABLE COLOURS

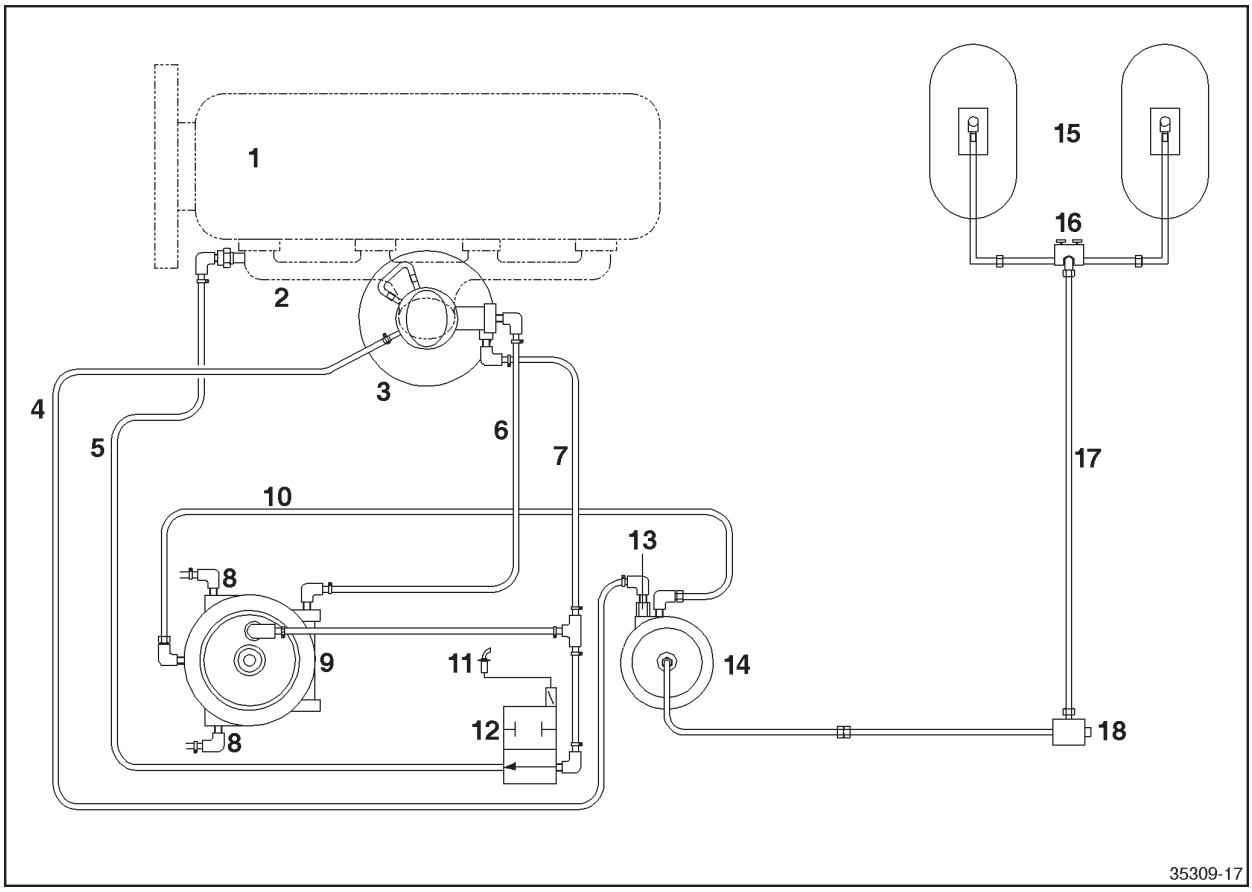
BK	black
BN	brown
BU	blue
GN	green
GY	grey
OG	orange
RD	red
VT	violet
WH	white
YE	yellow

CIRCUIT DIAGRAM H 50/60/70/80 T, TYPE 353, FROM 01/2005


30
15(K4)
15(S11)
Masse
143Ah
3,1KW
910W
2W
2W
3W
2W
1,2W
1,2W
1,2W
1,2W
1,2W
1,2W
1,2W
1,2W
42W
7,5W
30W
Stromlaufplan Sonderausrüstung Klimaanlage
Stromlaufplan Sonderausrüstung
Stromlaufplan Lamode-Regelung
Stromlaufplan Sonder-ausrüstung
Kabine
Heizung Rundumleuchte Beleuchtung
Arbeitsscheinwerfer Kabine (Option)
Kabine
Fahrpedal
6P3
P1
0000
h
H1
H2
H3
H4
H5
H6
H13
H24
H25
H26
H12
V1
V3
7V4
1A1
1R1
1T1
1T2
1T3
1T4
1T5
1T6
1E1
1E2
1E3
1E4
1E5
1E6
4F15
9F14
9F13
9F16
7F12
9X11
7X4
4H7
S1
S2
S3
S4
S5
S8
S14
S18
K1
K2
K3
K4
M1
G1
G2
B1
B2
N2
Y1
Y2
F3
F11
X1
X2
X5
X6
X7
X10
2x 2,5 RDBK
10 RD
6 RD
2,5 RD
16 RD
95 BK
15 BKRD
15 BKYE
15 BKWH
1,5 BKWH
1,5 BKBU
1,5 BKGN
1,5 BKGY
1,5 BKVT
1,5 BKRT
1,5 BKOR
1,5 BKBN
1,5 BKYEGN
1,5 BKWHGN
1,5 BKWHBU
1,5 BKWHBN
1,5 BKWHRT
1,5 BKWHOR
1,5 BKWHYEGN
1,5 BKWHWH
1,5 BKWHBK
1,5 BKWHGY
1,5 BKWHVT
1,5 BKWHYE
1,5 BKWHRD
1,5 BKWHGN
1,5 BKWHBN
1,5 BKWHYE
1,5 BKWHBU

4.9.3 PROPELLANT GAS SYSTEM

4.9.3.1 DIAGRAM



1 Drive motor
2 Intake manifold
3 Mixer
4 Vacuum conduct
Mixer - gas shutoff valve
5 Vacuum conduct
Intake manifold shutoff valve
6 Gas conduit
Vaporisor - Mixer
7 Vacuum conduct
Mixer - secondary stage of vaporisor
8 Cooling water conduit
Vaporisor heating

4.9.3.2 FUNCTIONAL DESCRIPTION OF THE PROPELLANT GAS SYSTEM

The various stages of the gas system are described below with their operating positions:

OFF POSITION

- Ignition start switch (11) open.
- Electromagnetic shutoff valve (12) in open position.
- Vacuum-controlled shutoff valve (14) closed.
- Throttle valve in mixer (3) closed.

ON POSITION

- Ignition start switch (11) closed.
- Electromagnetic shutoff valve (12) in closed position.
- Vacuum-controlled shutoff valve (14) in closed position.
- Throttle valve in propellant gas mixer (3) open.

START

During the starting process, the vacuum moves from the intake manifold (2) via the open throttle valve of the mixer (3) and the conduct (4) to the vacuum-controlled shutoff valve (14) and activates a diaphragm. This opens the shutoff valve and allows LP gas to flow through the conduit (10) to the primary valve in the vaporisor (9).

A vacuum also passes through conduit (6) in the secondary stage of the vaporisor (9) and activates the secondary valve via a diaphragm. Now depressurised gas flows through the open valve in gaseous form through the conduit (6) to the mixer, where it is mixed with the air and led as an ignitable mixture through the intake manifold (2) to the individual cylinders.

OPERATION

In operation, the position of the throttle valve changes through [the action of] the speed regulator, depending on the speed and load of the engine. The resulting increase or reduction of the vacuum controls the secondary diaphragm, via the conduit (6) from the mixer (3) to the vaporisor (9), and thereby the secondary valve, this vacuum then changes the gas flow and the proportions of the mixture in the mixer (3).

If the vacuum is increased because of a dirty air filter, this pressure will, through the conduct (7), oppose the opening pressure of the secondary diaphragm in the vaporisor (9). As a result the secondary valve in the vaporisor (9) will partially close, the gas flow will be reduced and an excess density of gas in the mixture will be prevented.

STOPPING

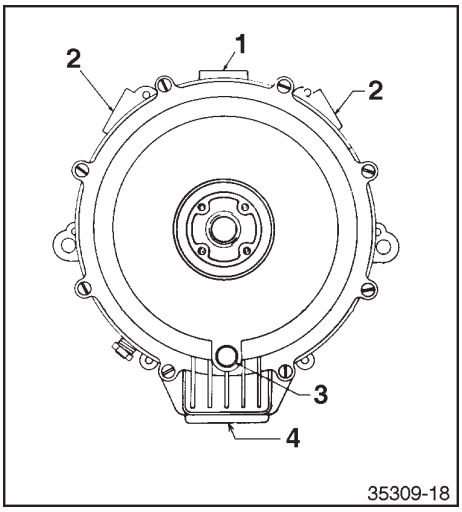
By switching off the ignition, the throttle valve in the propellant gas mixer (3) is closed. At the same time, the distributor valve (11) switches to open position, and the low pressure still present in the system is thereby led through the conduct (5) of the secondary diaphragm in the vaporisor (9) by the engine runoff in the intake manifold. This closes the secondary valve in the vaporisor, shuts off the gas flow and causes the engine to stop, with no run-on and no uncontrolled burning in the outlet. By closing the throttle valve, the vacuum is also filled in the conduit (4), the vacuum-regulated shutoff valve (14) closes and the LPG path to the vaporisor (9) is cut off.

After the engine stops and the steel-cylinder valves close, some liquid gas remains in the conduit (17). The pressure in the conduit (17) will now rise owing to the ambient temperature. The maximum possible pressure is limited by the valve (18) and thus an explosion of the conduit is avoided.

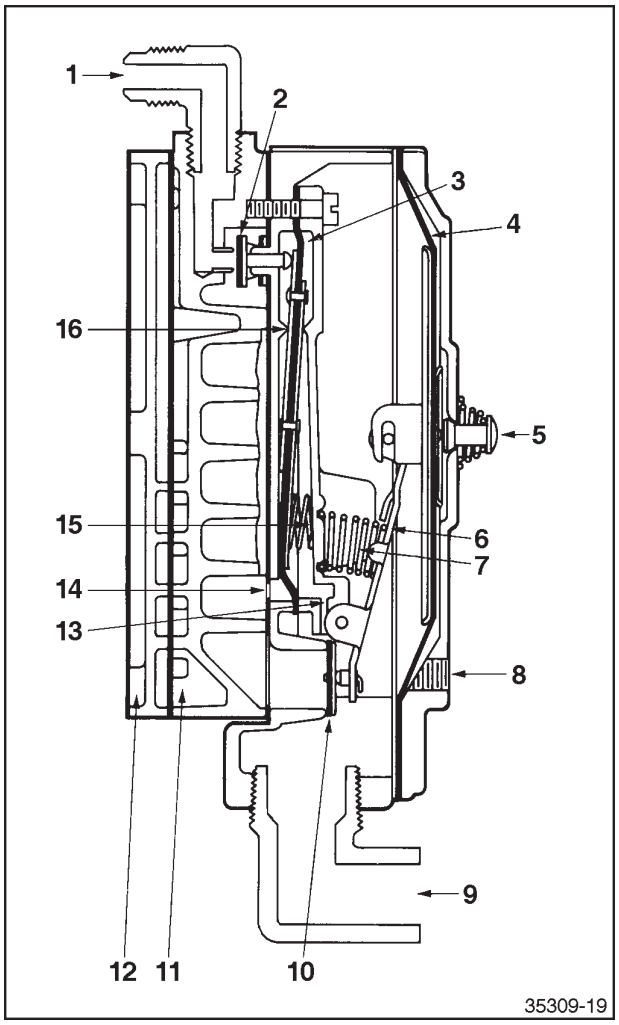
Service Training

VAPORISOR - PRESSURE REGULATOR MODEL E

1 LPG intake
2 Cooling water intake/outlet
3 Connection for compensating line
4 Outlet for evaporated gas



1 LPG inlet
2 Primary valve
3 Primary diaphragm
4 Secondary diaphragm
5 Manual actuator
6 Actuating lever
7 Spring of secondary diaphragm
8 Vacuum connection
9 Evaporated gas outlet exit
10 Secondary valve
11 Evaporation chamber
12 Water chamber
13 Compensating hole
14 Drilled hole
15 Primary valve springs
16 Primary diaphragm pivot
17 Secondary diaphragm connecting pin



OPERATION OF THE VAPORISOR

The LPG must be moved in gaseous form to process it with the intake air in the mixer as a flammable mixture.
This is achieved by means of the vaporisor, which is heated by the engine cooling water.

It works as follows:

The IMPCO vaporisor is a combined two-stage regulator with vaporisor. It receives the LPG at tank pressure from the vacuum-controlled shutoff valve with cleaning filter, and lowers this pressure in two stages to a little less than atmospheric pressure (low pressure).

In the “off” position (engine off), the primary valve (2) is open and the secondary valve (10) is closed. The secondary valve (10) prevents the gas from flowing out when the engine is off. This is assisted by the spring (7) under the actuating lever.

The primary valve (2) is controlled by the pressure in the vaporisor chamber (11), which acts on the primary diaphragm (3). This pressure passes through the hole (14) in the chamber in front of the diaphragm.

The diaphragm (3) moves around the pivot (16) and thereby presses the valve (2) in its seat. The spring (15) creates the counter-pressure. The back of the primary diaphragm (3) is linked to the atmospheric pressure via the compensating hole (14).

The secondary valve (10) can be activated mechanically by the manual actuator (5) for a cold start .

With the motor running (throttle valve of mixer open), a vacuum is created in the gas conduct to the mixer, and this vacuum opens the secondary valve (10), so that the LPG can flow through the open primary valve (2) into the vaporisor. The secondary valve (10) is controlled by the secondary diaphragm (4).

Due to the lowering of the pressure of the LPG (c. 10 bar in the tank) to atmospheric pressure, the LPG expands, which results in a temperature drop. To compensate for the cooling and accelerate the evaporation, the vaporisor is heated. To this end, the cooling water is passed through the water chamber (12) of the vaporisor. By setting the throttle valve (by the position of the drive pedal), the secondary diaphragm (4) is adjusted up or down, whereby the opening of the secondary valve (10) is controlled.

If the vacuum is increased by a dirty air filter, this vacuum opposes the opening pressure of the secondary diaphragm (4) via connection (8). As a result, the secondary valve (10) is partly closed, the gas flow will be reduced and an excess density of gas in the mixture will be prevented.

When the engine stops, the vacuum rises at connection (8). The secondary valve (10) shuts completely. No more gas can now flow to the mixer.

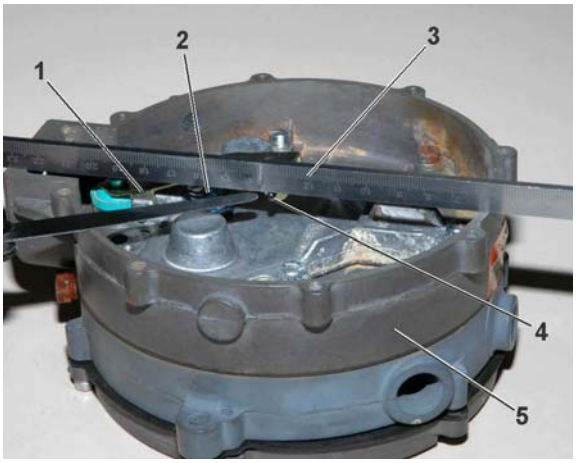
MAINTENANCE ON VAPORISOR

Maintenance on the vaporisor should include the checking of the secondary valve actuating lever (1). The Impco maintenance kits are used for two different vaporisor types (series E and EP). As a result, a check must be carried out, and, if necessary, the actuating lever (1) has to be bent accordingly.

To carry out the check and the bending adjustment, proceed as follows:

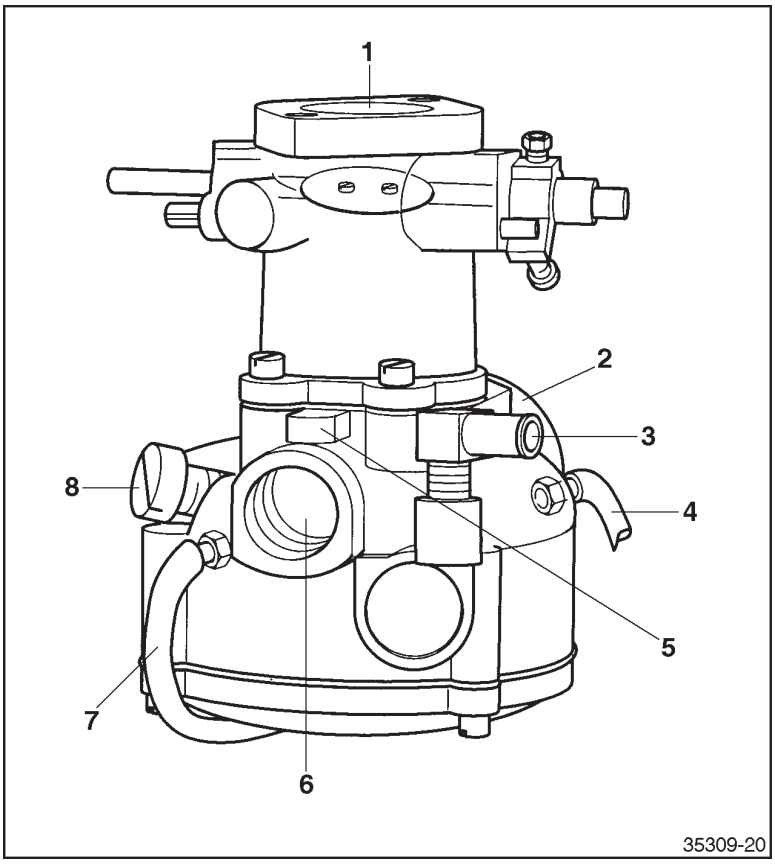
After assembly of the maintenance kit, check the position of the connecting pin (4) using a setting bar (3) and a feeler gauge. A setting bar is placed over the housing (5). The spring (2) pushes the valve into its closed position. The distance between the connecting pin (4) and the setting bar (3) must be 1 mm. If necessary, the actuating lever (1) should be bent to achieve this dimension.

1 Actuating lever
2 Spring
3 Setting bar
4 Secondary diaphragm connecting pin
5 Vaporizor housing



PROPELLANT GAS MIXER

The correct proportions for the gas-air mixture are important for problem-free running of the engine. For this purpose, a mixer valve (the mixer) serves for the correct dosing of gas and air.



1 Mixture outlet to engine
2 Air intake from air filter
3 Vacuum connection – magnet valve, secondary diaphragm
4 Vacuum connection – shutoff valve
5 Full load mixture – adjustment screw
6 Gas intake – from vaporisor
7 Transmission tube – vacuum to diaphragm
8 Idling mixture – adjustment screw

It works as follows:

When the engine starts, a vacuum is passed through the connection (4) to the gas shutoff valve and opens the valve.
This enables LPG to flow to the vaporisor and from there to reach the mixer via connection (6) in a gaseous state. The fresh air flowing into the mixer at connection (2) is processed in the mixer into an ignitable mixture and reaches the intake manifold through connection (1) and from there into the individual engine cylinders.
Through connection (7), the vacuum is passed to the gas-air regulating valve and thus regulates the opening of this valve.
With adjustment screws (5) and (8), two limited mixture ratios are adjusted.

MIXTURE ADJUSTMENT FOR IDLING

The air and gas mixture which flows past the almost-closed throttle valve in idling mode is constant. In idling mode, part of the inflowing air is conducted to the air inlet valve. The idling setting is controlled using the idling mixture adjustment screw (8), by which the gas-air mixture in idling mode is thinned or enriched.

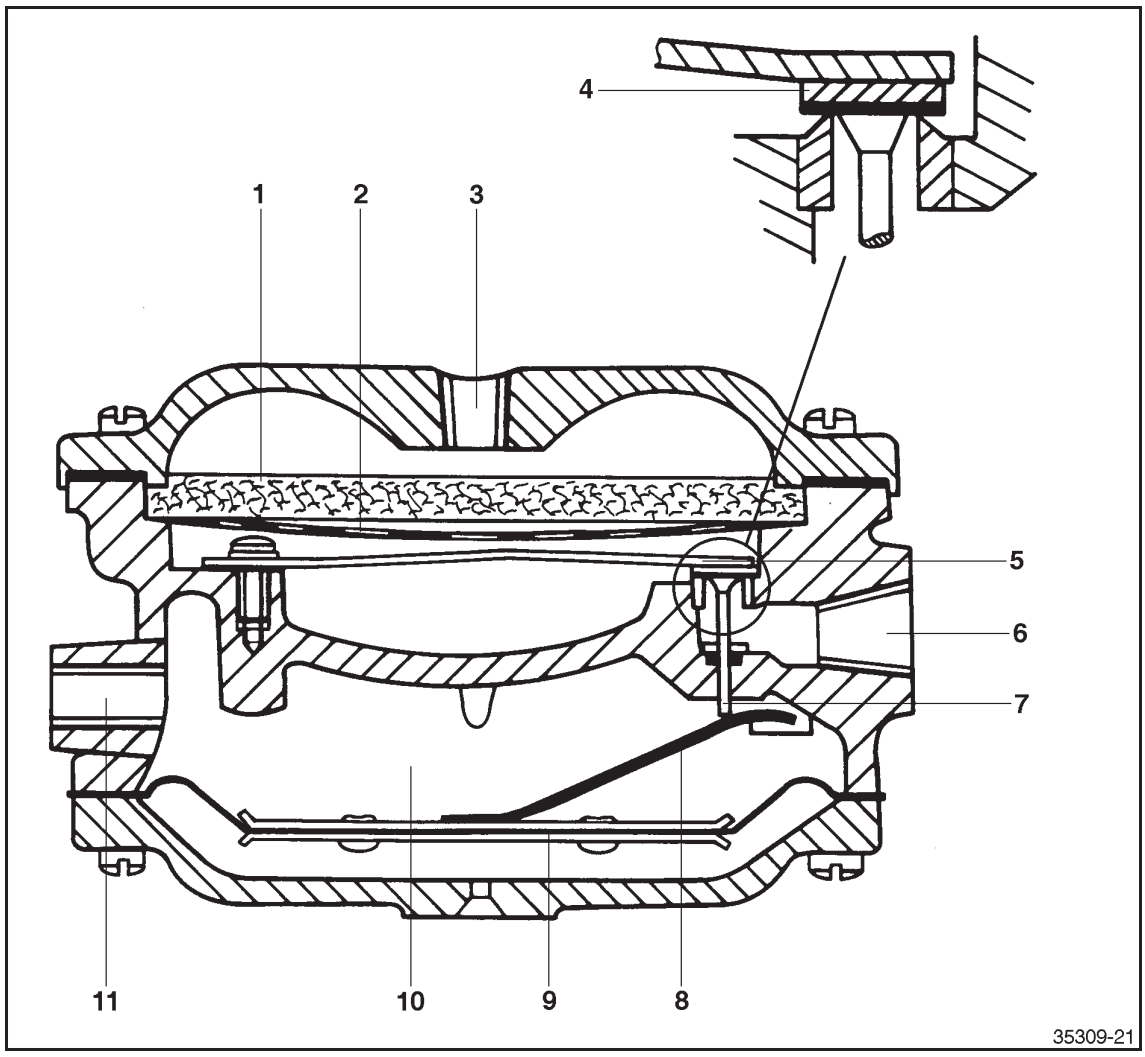
MIXTURE ADJUSTMENT FOR FULL LOAD

This setting controls the mixing proportions if the gas regulator valve is open. This setting is only effective if the engine is approaching its maximum load. The setting of the full load mix adjusting screw (5) can only be effective with an engine under full load close to its maximum r.p.m. speed (rated speed).

Mix formation between idling and full load conditions is controlled by the form of the gas regulation valve. The gas regulation valve is formed in such a way that with a smaller load the mixture is thinner and as the load and engine speed rise, the mixture is steadily enriched.

FUNCTIONING OF THE VACUUM-CONTROLLED SHUTOFF VALVE

When the engine is off, the shutoff valve is in closed position. No LPG can flow to the vaporisor. When the engine is started, a vacuum is present in the intake section, which develops through the intake stroke of the engine. This vacuum is passed through a tube connection from the mixer via connection (11) to the top of the diaphragm (9) in the shutoff valve. The pressure difference between the top and bottom of the diaphragm (9) creates an upward displacement of the diaphragm. The diaphragm (9) thereby activates the lever (8) which acts on the valve shaft (7). The valve shaft (7) is displaced upwards and thereby opens the plate valve (4) against the initial tension of the leaf spring (5). LPG can now flow through the filter plate (1) to the vaporisor.



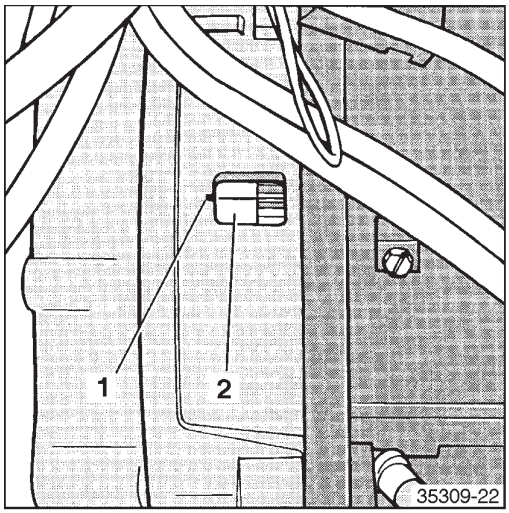
1 Filter plate
2 Supporting plate, perforated
3 LPG intake
4 Plate valve
5 Leaf spring, to shut valve
6 LPG outlet, filtered
7 Valve shaft
8 Diaphragm lever, to open valve
9 Diaphragm
10 Vacuum space
11 Vacuum inlet from mixer

4.9.4 INSPECTIONS AND ADJUSTMENTS

4.9.4.1 IGNITION SYSTEM

CHECKING THE FIRING POINT

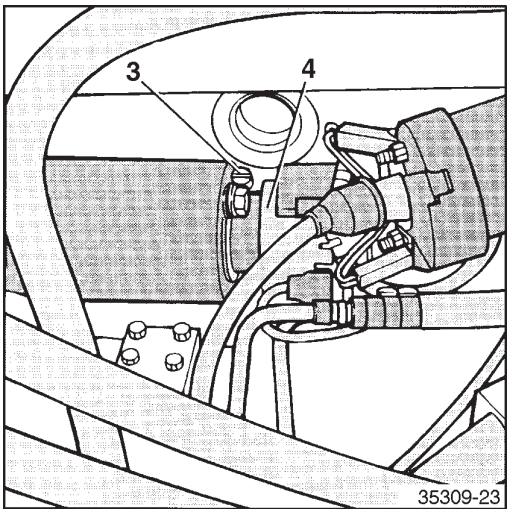
NOTE: The firing point can only be checked and adjusted dynamically using a strobe light.



- Let the engine warm up.
- Stop engine and switch off ignition.
- Connect strobe lamp according to manufacturer's instructions.
- Start engine.
- Let engine run at idling speed of 800 rpm.
- Shine the strobe light at the firing point mark 18 ° before TDC on the flywheel (2) (vertically from above).

NOTE: With the correct setting, the marking on the flywheel must be flush with notch (1) on the housing.

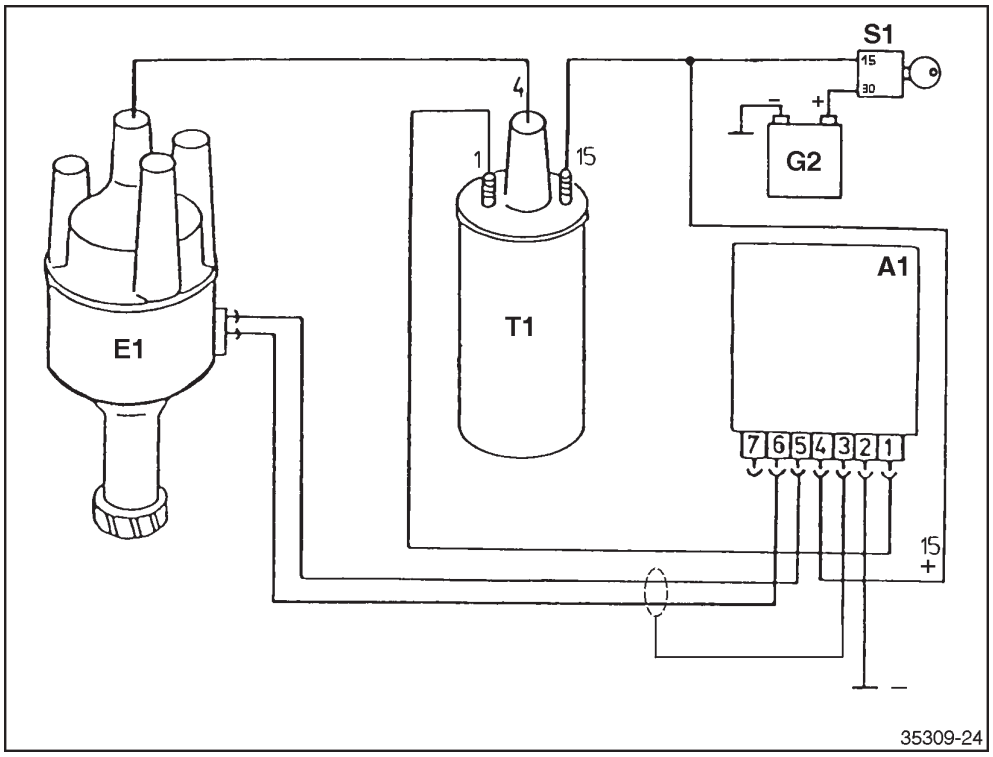
ADJUSTING THE FIRING POINT



- Loosen clamping screw (3) on ignition distributor (4) to the point where it can just be turned manually.
- Shine the strobe light on the markings.
- Twist the ignition distributor so that the 18 ° marking on the flywheel is flush with the notch on the housing.
  Turning clockwise: Earlier ignition
  Turning counter-clockwise: Later ignition
- Refasten the clamping screw after the adjustment and check the setting again.

NOTE: There are two markings of different lengths on the flywheel. In the direction of rotation of the engine, the short marking appears first as the firing point, the second, longer marking as TDC.

INSPECTION OF THE IGNITION SYSTEM



A1	Transistor-coil ignition (TSZ) switchgear	G2	Battery
E1	Ignition distributor with induction-type pulse generator	S1	Ignition starting switch
		T1	Ignition coil

IGNITION CABLE

Resistance 2.5 – 4 kΩ depending on the length of the cable

Resistance of the cable from terminal 4 of the ignition coil
to the central connection of the distributor head: 22 – 26 kΩ

IGNITION COIL T1

- Measure primary resistance between terminal 1 (-) and 15 (+)
  Target value: 0.6 – 1.0 Ω
- Measure secondary resistance between terminal 4 and 15
  Target value: 6 - 10 kΩ

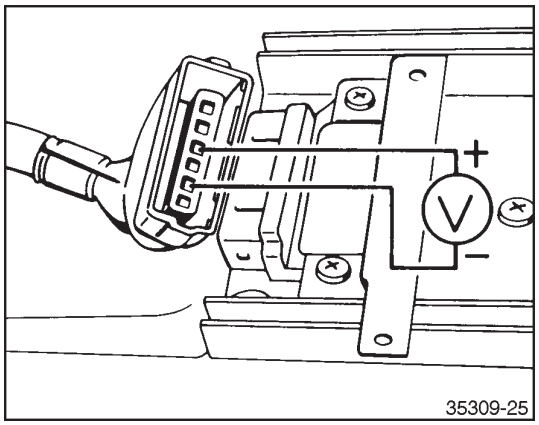
SWITCHGEAR A1

TEST CONDITION

- Ignition coil in order

TESTING

- Pull out plug from TSZ switchgear and press wire fuse.



- Connect voltmeter to the plug between contact 4 (+) and 2 (-).

- Switch ignition on.
  Target value: about the same as battery voltage, otherwise determine interruption on the basis of wiring diagram and remove it.

- Switch ignition off.

- Insert the plug back into the TSZ switchgear.

- Take the plug out of the induction transmitter (ignition distributor).

- Draw out the high-voltage transmission line terminal 4 from the ignition distributor and earth it with an emergency cable.
- Plug two electric cables into the sockets of the two-pin plug of the induction transmitter, and tap the plus and minus sides of a 1.5 volt battery with their ends. For each tap a spark should be produced on cable 4. Change the polarity in the battery if necessary.

NOTE: If no spark appears, the cable connection from the plug to switchgear terminal 4 and terminal 5 is to be inspected and, if necessary, corrected. If there is still no spark formation, the switchgear is defective.

Induction transmitter

Test conditions

- TSZ switchgear in order
- Ignition coil in order.
- Lines between switchgear and ignition distributor in order.

Testing

- Remove the plug of the TSZ switchgear and take a measurement of the resistance between terminals 5 and 6 of the plug.
  Target value: 450 – 1000 Ω depending on air gap between stator and rotor arms.
- Switch meter to a.c. voltage and to the millivolt measuring range.
- Connect test prods of meter with sockets 5 and 6 of the switchgear plug.
- Turn the engine with starter motor and read off voltage on meter.
  Target value: 300 – 700 mV, depending on starting speed.

4.9.4.2 INSTALLATION OF THE ENGINE SPEED CONTROL SYSTEM

TARGET VALUE TRANSMITTER

1. Install terminal nut (6) on piston rod of adjustment cylinder (8) (terminal nut must make contact with adjustment cylinder housing).

2. Align red marking (5) on the target value transmitter (1) in line with the red marking on the housing.

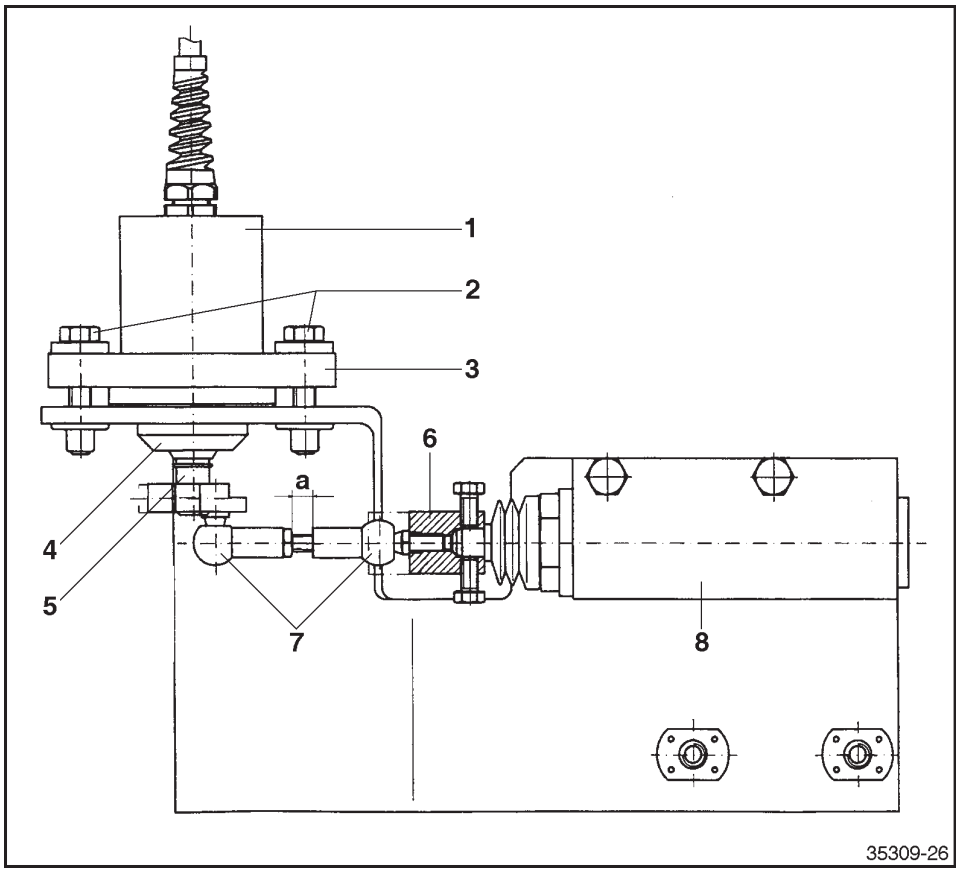
3. Install target value transmitter (1) and tighten screws (2) on terminal flange (3) hand-tight only.

4. Attach connection rods (7) to adjustment cylinder (8). Preset measurement “a” to 6 mm.

5. Connect voltmeter between plug X/B2:2 and X/B1:2. With the plugs still connected, insert test prods on the back into the indicated measuring points. For this purpose, the rubber coating must be removed from plug X1. Switch ignition on. Twist target value transmitter (1) until the meter shows a value of 700 to 800 mV.

6. Tighten terminal screws (2) of target value transmitter (1).

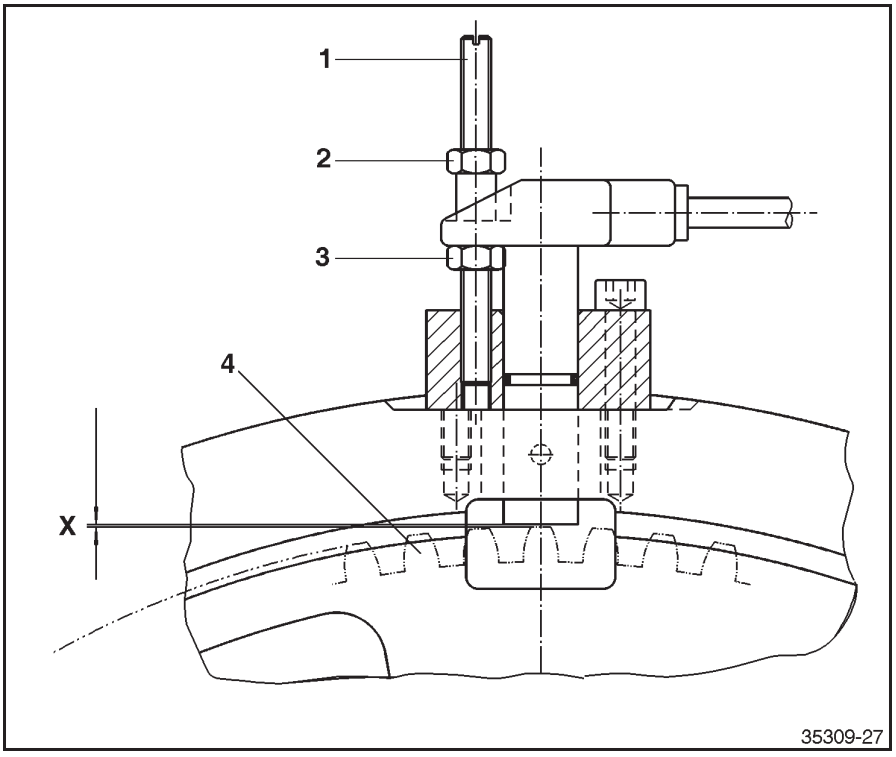
7. Set the precision adjustment using rod assembly (7) to 740 to 760 mV and fix with a nut.



ACTUAL VALUE TRANSMITTER

WARNING: For adjusting or installation work on actual value transmitter B1 and with X/B1 plugs disconnected (see engine speed control connection plan), the engine may in no circumstances be started. Otherwise the engine races (no actual value signal for speed control N2).

- Loosen nuts (2) and (3) to adjust [the transmitter].
- Insert sensor gauge through the opening on the intermediate housing, between toothed ring (4) and actual value transmitter B1.
- The correct distance measurement “X” between toothed ring (4) and actual value transmitter B1 must be 0.5 $^{+0.3}$ mm.
- Attach nut (3) on actual value transmitter B1 back on the assembly and secure the actual value transmitter again by tightening nut (2) (10 Nm).



4.9.4.3 INSPECTION OF THE ENGINE SPEED CONTROL SYSTEM

Before starting these checks:

- Jack the truck up securely so that both drive wheels can turn freely.
- Lock brake pedal in “brake locked” position.
- Engine is warmed up.

APPLIANCES AND MEASURING TOOLS

- Digital meter
- Tachometer
- Connection plan for engine speed control
- Electrical system circuit diagram

ENGINE SPEED CONTROL SYSTEM CONNECTION PLAN

X/B1 Rotation speed actual value transmitter B1

X/B2 Rotation speed nominal value transmitter B2

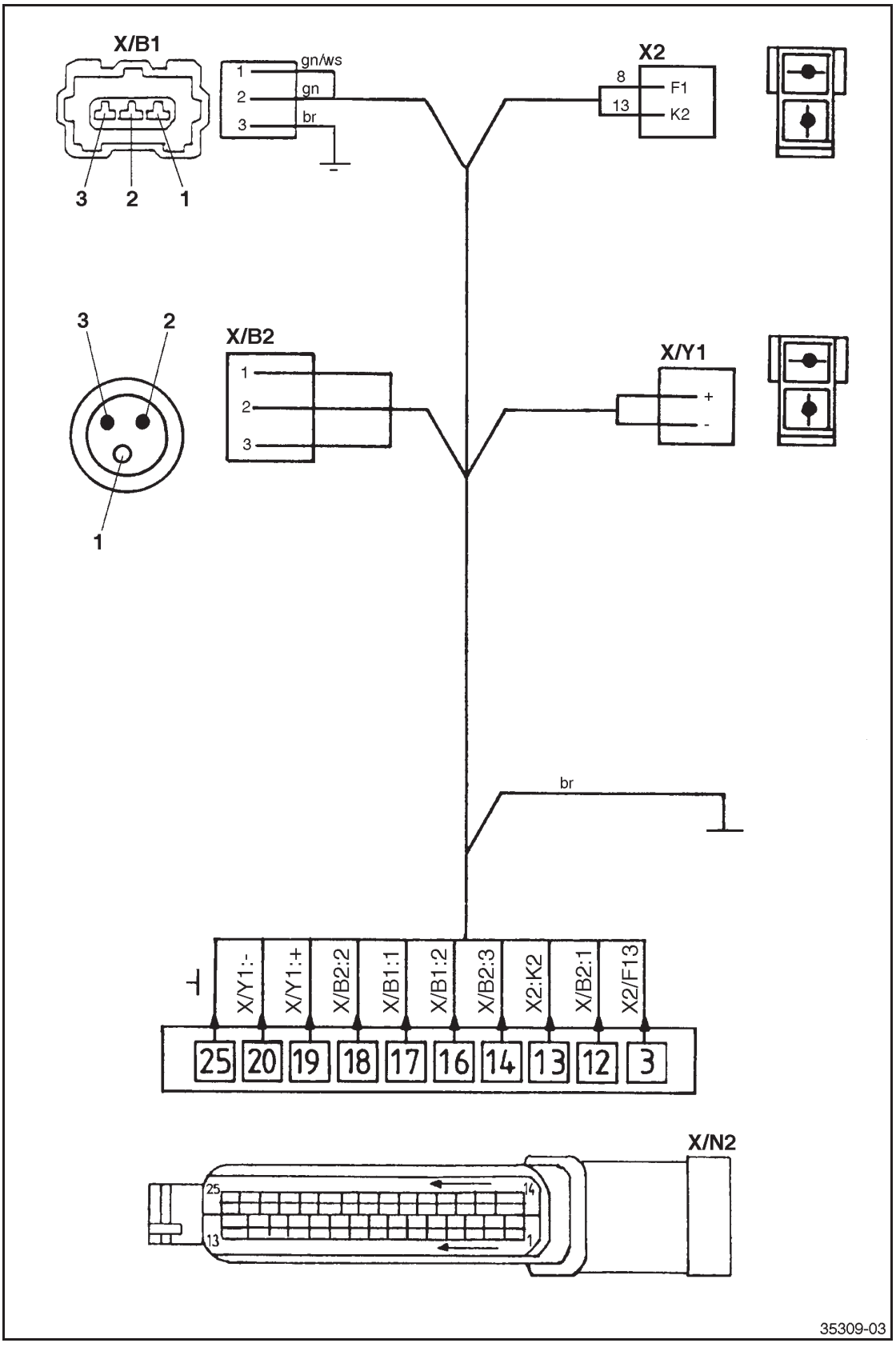
X2 Fuse F13, starting relay K2

X/Y1 Operating magnet Y1

X/N2 Speed regulator N2

NOTE: Plug X2 is in the central electrical system behind the covering of the second step.

WARNING: Plug X/B1 may not be disconnected at the from the actual value transmitter during the starting procedure, since otherwise the engine races.


X/B1
gn/ws
gn
br
1
2
3
3
2
1
X2
8
13
F1
K2
X/B2
1
2
3
3
2
1
X/Y1
+
-
br
⊥
X/Y1:-
X/Y1:+
X/B2:2
X/B1:1
X/B1:2
X/B2:3
X2:K2
X/B2:1
X2/F13
25
20
19
18
17
16
14
13
12
3
X/N2
25
14
13
1
35309-03

ELECTRONIC CONTROL SYSTEM

ENGINE SPEED REGULATOR SUPPLY VOLTAGE

- Connect voltmeter between the connections X/N2:3 and X/N2:25 on the disconnected plug X/N2.

- Switch ignition on.

- The meter should show 12 V (= supply voltage) from engine speed regulator N2.

NOTE: If this value is not obtained, check cabling (+) and (-) supply line.

- Plug X/N2 plug back into the engine speed regulator N2.

SPEED REGULATOR MIDPOINT VOLTAGE

NOTE: A precise midpoint voltage is required for the following measurements and for the correct operation of the speed regulator.

- Disconnect plug X/B1 and connect meter (voltmeter) between connection X/B1:2 and earth of truck.

- Switch ignition on.

- Meter should show 5 V = midpoint voltage.

NOTE: If the meter shows no voltage value or an incorrect value, the cabling on plug X/B1 and the supply voltage from N2 must be checked or speed regulator N2 replaced.

- Reconnect plug X/B1.

NOMINAL VALUE TRANSMITTER

- Connect meter for voltage measurement between connections X/B2:1 and X/B1:2. The plugs remain connected. Plug in the measuring prods at the indicated measuring points.For this purpose, the rubber bush must be removed from plug X/B1.

- Switch ignition on.
  Meter shows voltage of 2 V (preset by speed regulator).

- Voltage measurement between connections X/B2:3 and X/B1:2. Plugs remain connected. Plug in the measuring prods at the indicated measuring points. For this purpose, the rubber bush must be removed from plug X/B1. Meter shows voltage of 750 $\pm$ 15 mV (preset by speed regulator).

- Voltage measurement between connections X/B2:2 and X/B1:2. (Voltage value of the basic setting). The plugs remain connected. Insert the measuring prods at the indicated measuring points. For this purpose, the rubber bush must be removed from plug X/B1.
  Meter shows voltage of 750 ± 10 mV.

- Start engine.

- Press an accelerator pedal fully down until the end stop. The voltage on the meter must likewise steadily rise from 750 ± 10 mV to 2 V.

NOTE: If the four measurement values are not obtained, the basic setting of the target value transmitter B2, the cable connections, the supply voltage and the midpoint voltage must be checked or the speed regulator N2 or target value indicator B2 must be replaced.

ACTUAL VALUE TRANSMITTER

- Disconnect plug X/B1.

- Attach test cable of a meter on the connections X/B1:2 and X/B1:1 and take a resistance measurement.
  Target value: 1 kΩ ± 100 Ω

- Switch meter to a.c. voltage and to set to 100 V measuring range.

- Disconnect speed regulator N2.

- Turn engine with starter motor and read off voltage on meter.
  Target value: 5 - 15 V

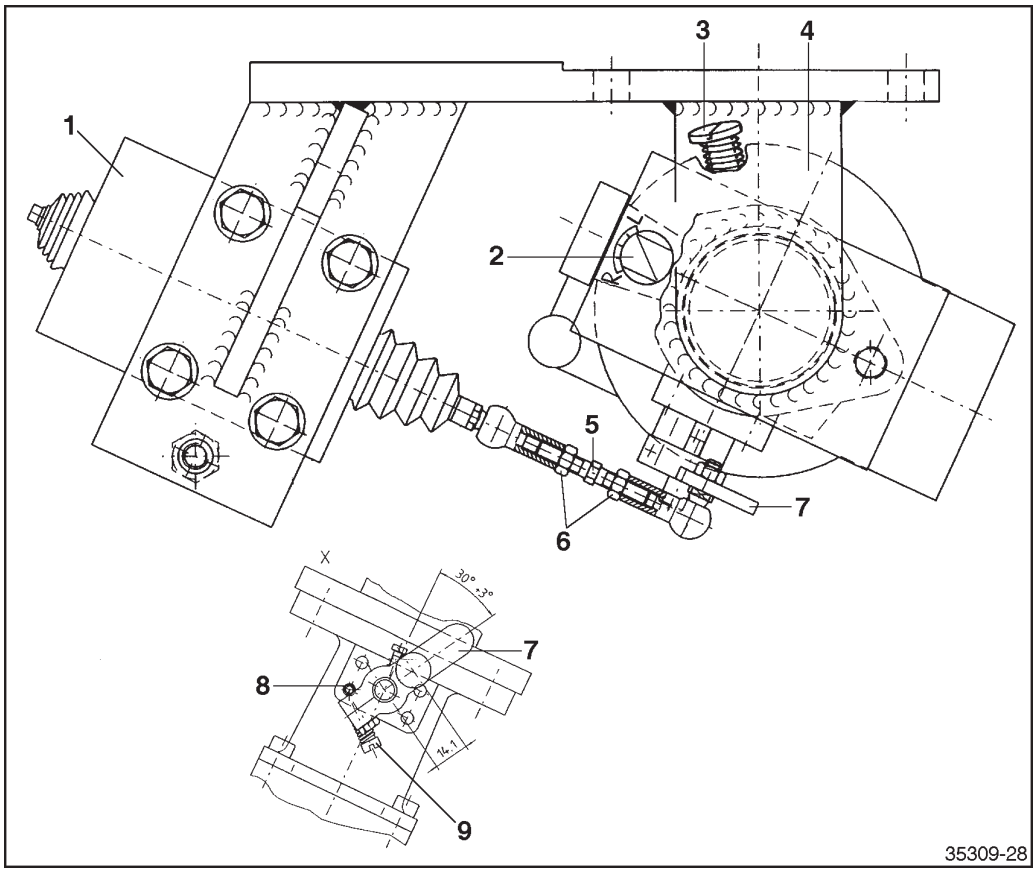
- Connect tachometer.

- Manually draw out operating magnet axis by about 1/3 and start engine. Set an engine speed of about 750 rpm by manual activation of the operating magnet axis and read off voltage on meter.
  Target value: 20 - 40 V

- Now let engine speed rise to 2100 rpm by manual activation of the magnet axis and read off voltage on meter.
  Target value: 50 - 100 V

NOTE: The voltage values listed here vary within the tolerances mentioned, depending on the setting of the actual value transmitter, and may diverge still further, depending on the meters used. The testing serves only to determine whether the voltage value, i.e. the output signal, varies with variations in engine speed.

4.9.4.4 ADJUSTMENT OF THE PROPELLANT GAS MIXERS



1 Operating magnet
2 Full load mixture adjustment screw
3 Idling mixture adjustment screw
4 Mixer
5 Connecting rod
6 Lock nut
7 Lever
8 Limit stop
9 Limit stop screw

ASSEMBLY

- Close throttle valve manually.

- Adjust limit stop screw (9) so that with the throttle valve at the limit stop (8) closed, it approaches the assembly, and then turn back 1 more turn.

- Move lever (7) on shaft and clamp at an angle of 30 $^{+3}$ °.

- Install mixer.

- Press throttle valve manually onto the limit stop and adjust connecting rod (5) between magnet (1) and lever (7) to an initial tension of 1 mm and press on ball grip of lever (6).

- Lock rod (5) with nuts (6).

ADJUSTING THE CO CONTENT

Prerequisites for adjustment:

- Firing point checked and if necessary corrected: desired value 18 ± 2 ° before TDC (from 01/2005: 8 ± 2 ° before TDC).
- With truck warmed up, hydraulic oil at 60 – 70 °C, operating hydraulics pressure relief valve set to 265 bar.
- Parking brake locked in braked position.

Adjustment:

- Turn idling mixture adjustment screw (3) to its limit stop and then unscrew by three turns.
- Connect CO meter.
- Start engine and when truck is warmed up at a low idling speed (750 – 800 rpm) determine CO value.

Target value: CO ≤ 0.1 % by volume
If CO > 0.1 % by volume, unscrew screw (3) more, engine must be running in idling mode but clearly regularly.

- Place full-load mixture adjustment screw (2) in the middle between L and R (the screw is located at the gas intake in the mixer).
- Connect CO meter.
- With the footbrake on, bring the engine to maximum running speed, activate tilt control lever fully to the limit stop and hold there, at the same time turn the steering to the limit stop too, and hold, thereby applying a load to the engine.
- Determine CO value of the engine under this load.

Target value: CO ≤ 0.1 % by volume

Correction: To reduce CO value = turn adjustment screw in direction L.

To increase CO value (to enhance engine performance) = turn adjustment screw in direction R.

NOTE: The engine cannot be set to this setting with a running speed lower than 1750 rpm. In models with catalysers, the speed cannot go below 1850 rpm.

- Screw in limit stop screw (9) against limit stop (8) to the point that when pressing the magnet axis up to the limit stop, the running speed is kept at about 500 rpm.

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